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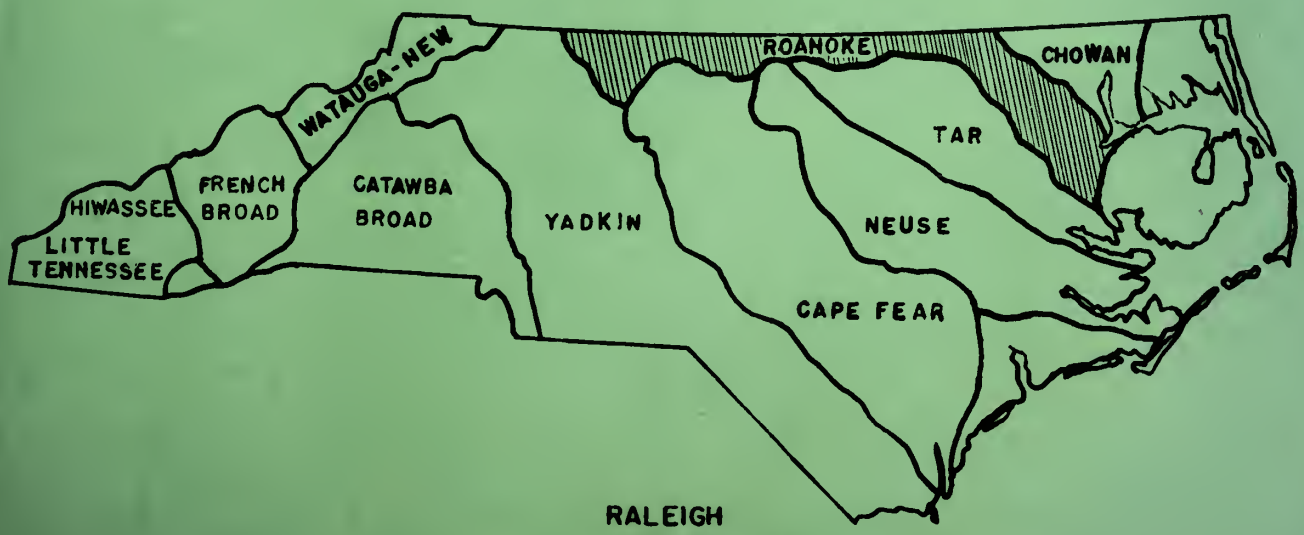
WATER RESOURCES OF NORTH CAROLINA

ROANOKE RIVER BASIN



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FOREWORD

This publication comprises Volume V of a series of eleven volumes containing information regarding the water resources of North Carolina. Volumes I to IV, inclusive, were published as follows:

I State as a whole, January 1955
II Neuse River Basin, May 1955
III Yadkin-Pee Dee River Basin, August 1955
IV Chowan River Basin, December 1955

Volumes VI-XI, inclusive, will provide inventories of the water resources of the French Broad, Cape Fear, Broad-Catawba, Tar-Pamlico, Hiwassee-Little Tennessee, and Kanawha-Watauga River Basins. Drafts of inventories of the French Broad and Cape Fear River Basins are substantially completed. Some progress on drafting the inventory of the Broad-Catawba River Basin has been made. When the contemplated series are completed, information pertaining to the entire State will be available to assist in the orderly planning and development of the water facilities required for municipal and industrial expansion and for the expansion of the uses of water for agriculture; to guide watershed authorities, basin associations, soil conservation districts, and other agencies concerned with water uses in accomplishing their purposes; and to provide aid to the Board of Water Commissioners of the State of North Carolina, created by the 1955 Session of the General Assembly of North Carolina.

It is hoped that this publication will assist in the location, development, and expansion of municipal, industrial, agricultural, and other water supplies, and will serve as a guide to the future study of water resources in the Roanoke River Basin.

Grateful appreciation is hereby extended to persons who provided material specifically indicated in several chapters of this volume and also to persons who provided material for this volume as follows:

Corps of Engineers, U. S. Army
Chapters I, XI, and XII
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Chapter XII

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CHAPTER I - DESCRIPTION OF WATERSHED

Main Stream - The Roanoke River rises on the eastern slope of the Appalachian Mountains, flows in a southeasterly direction toward the Atlantic Coast, and empties into Albemarle Sound, approximately seven miles below Plymouth, North Carolina. The Roanoke River Basin is located in the southern part of Virginia and in the northern part of North Carolina. It is bounded on the north and east by the watersheds of the James and Chowan Rivers, on the west by the watershed of the New River, and on the south by the watersheds of the Tar-Pamlico, Neuse, Cape Fear, and Yadkin Rivers. It is approximately 200 miles long and from 10 to 100 miles wide, and covers a drainage area of 8,580 square miles, of which 6,160 square miles are in Virginia and 3,420 square miles are in North Carolina. Parts of 15 counties in Virginia and 17 counties in North Carolina are included in the watershed.

Between the mouth of the Dan River at Clarksville, Virginia, and the mouth of the Pigg River near Altavista, Virginia, the Roanoke River is known as the Staunton River and as the Roanoke River upstream from the mouth of the Pigg River. The principal tributary of the Roanoke River is the Dan River. Other important tributaries of the Roanoke River are Goose Creek and the Blackwater, Pigg, Otter, Falling, and Cashie Rivers. Since all of the important tributaries of the Roanoke River except Dan River and Cashie River lie wholly within Virginia, only the latter two tributaries will be further referred to in this publication.

Tributaries - The Dan River, with a drainage area of 9,580 square miles, rises in Virginia about 20 miles north of the Virginia-North Carolina State line. It flows in a generally southeasterly direction to the northwestern corner of Stokes County, thence alternately in easterly and southerly directions to the southeastern part of Stokes County, and thence generally northeasterly through Rockingham County, crossing the North Carolina-Virginia State line in the northeastern part of Rockingham County, passing through Danville, Virginia, and entering the Roanoke River at Clarksville, 200 river miles above the mouth. The Dan River re-enters North Carolina in the northeastern corner of Rockingham County and returns to Virginia in the northwestern corner of Caswell County, and also flows in a loop in Caswell County, re-entering North Carolina approximately in the center of the northern boundary of the County and returning to Virginia at a point on the northern boundary of the County about seven miles from the second re-entrance indicated above. The principal tributaries of Dan River are Smith River, Mayo River, Sandy River, Bannister River, and Hyco River. Since Sandy and Bannister Rivers lie wholly within Virginia, they will not be referred to further in this publication.

Smith River, with a drainage area of 550 square miles, rises in Virginia near the source of the Dan River. It flows northeasterly for about 30 miles, thence in a generally southeasterly direction to a point about 3 miles north of the Virginia-North Carolina State Line, and thence in a southerly direction to its confluence with the Dan River at Leaksville, in Rockingham County.

Mayo River, with a drainage area of 327 square miles, rises in Virginia about 13 miles north of the Virginia-North Carolina State Line. It flows in a generally southeasterly direction to the Virginia-North Carolina State Line near the boundary between Stokes and Rockingham Counties, and thence southeasterly

and southerly to its junction with Dan River about three miles southeast of Madison in Rockingham County.

The confluence of North Hyco Creek, rising near the Town of Baynes in the southeastern part of Caswell County, and South Hyco Creek, rising near the intersection of the Person-Orange County Line and the Person-Caswell County Line, forms the Hyco River at a point about 0.5 mile southwest of McGhees Mill in the northwestern corner of Person County. Hyco River joins the Dan River about 10 miles east of South Boston, Virginia, and has a drainage area of 313 square miles.

Cashie River rises in the northwestern corner of Bertie County near the Town of Roxobel. It flows in a generally southeasterly direction throughout Bertie County and empties into Albemarle Sound about 0.5 mile east of the mouth of the Roanoke River, to which it is connected by Broad Creek and Middle River in a maze of waterways at the mouths of Roanoke and Cashie Rivers.

Topography - The Roanoke River Basin in North Carolina lies within two physiographic provinces known as the Piedmont Plateau and the Coastal Plain. The dividing line between these provinces passes about 2.5 miles west of Roanoke Rapids. The Piedmont Plateau is characterized by rolling conformation, with elevations ranging from 150 to 900 feet above sea level. The Piedmont area is traversed by highlands which are cut by numerous tributary valleys. Below the fall zone, or eastern escarpment of the Piedmont Plateau near Roanoke Rapids, the basin lies on the Coastal Plain, a flat featureless region, rising in a series of terraces to an elevation of 150 feet above mean sea level. Tributaries in this area are shallow and meandering.

The altitudes of various North Carolina cities and towns in the Roanoke River Basin are shown below:

BERTIE	
Askewville	64
Kelford	88
Lewiston	76
Windsor	10
Woodville	5
CASWELL	
Corbett	800
Milton	750
Pelham	740
Purley	600
Yanceyville	619
FORSYTH	
Kernersville	1023
GRANVILLE	
Bullock	429
Stovall	478
HALIFAX	
Halifax	135
Hobgood	91
Littleton	398
Roanoke Rapids	169
Scotland Neck	103
Tillery	64
Weldon	78
MARTIN	
Amherst	75
Everett	66
Jamesville	47
Williamston	60
NORTHAMPTON	
Garysburg	145
Rich Square	78
PERSON	
Roxboro	671
Woodsdale	482
ROCKINGHAM	
Leaksville	700
Mayodan	594
Reidsville	841
Ruffin	712
Stoneville	823
STOKES	
Danbury	825
Germanton	662
Walnut Cove	689
VANCE	
Greystone	493
Henderson	513
Middleburg	494
Townsville	421
WARREN	
Norlina	438
Ridgeway	422

WARREN (Cont.)

Vaughn	353
Warrenton	451
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Plymouth	21

Geology - The geological formations of the Roanoke River watershed vary widely with the physiographic regions. The Piedmont area is formed largely in very old sedimentary and igneous rocks that have been so greatly altered through metamorphism that most of them bear but slight resemblance to the original rocks. Excluding a narrow belt of Triassic shales, sandstones, and conglomerates, all of the rocks of the Piedmont Plateau are of crystalline types and comprise a complex of schists, gneisses, and granites.

The geological formations of the Coastal Plain consist of irregularly stratified and unconsolidated beds of sedimentary gravel, sand, clay, and marl. These sediments rest upon crystalline rocks which lie at depths varying from a few feet at the fall zone to considerable depth at the mouth of the river.

Population - Cities and towns with a population of over 1,000 (U. S. Census of 1950) are shown in the following table:

COMMUNITY, COUNTY	1920	1930	1940	1950
Ahoskie, Hertford			2,313	3,579
Aulander, Bertie			1,057	1,112
Draper, Rockingham				3,629
Gaston, Northampton				1,218
Kernersville, Forsyth			2,103	2,396
Leaksville, Rockingham			1,886	4,045
Littleton, Halifax			1,200	1,173
Madison, Rockingham			1,683	1,789
Mayodan, Rockingham	1,886	1,948	2,323	2,246
Plymouth, Washington	1,847	2,139	2,461	4,486
Reidsville, Rockingham	5,333	6,851	10,387	11,708
Roanoke Rapids, Halifax	3,369	3,404	8,545	8,156
Roxboro, Person			4,599	4,321
Scotland Neck, Halifax	2,061	2,329	2,559	2,730
Walnut Cove, Stokes			1,084	1,132
Weldon, Halifax	1,872	2,323	2,341	2,295
Williamston, Martin	1,800	2,731	3,966	4,975
Bertie, Windsor			1,747	1,781
Yanceyville, Caswell				1,391

- - - - - -

The population and growth of counties within or partially within the basin are as follows:

COUNTY	1940	1950
Bertie	26,201	26,439
Caswell	20,032	20,870
Forsyth	126,475	146,135

COUNTY	1940	1950
Granville	29,344	31,793
Halifax	56,512	58,377
Martin	26,111	27,938
Northampton	28,299	28,432
Person	25,029	24,361
Rockingham	57,898	64,816
Stokes	22,656	21,520
Vance	29,961	32,101
Warren	23,145	23,539
Washington	12,323	13,180

Natural Resources - The variety of minerals found in the basin is extensive. Because of limited quantities, however, their commercial importance is small. Large quantities of stone, suitable for building purposes and road construction, occur throughout the Piedmont region, with developed quarries in the vicinity of Henderson. Commercial gravel deposits occur near Garysbury in the Coastal Plain area. Several ceramic industrial plants in the basin are engaged in the production of structural clay products.

Industrial Development - Manufacturing establishments, producing a variety of commodities, are located throughout the watershed. The principal products are textiles, pulp, paper, rayon, building materials, and furniture. The largest industrial center in the North Carolina portion of the basin is at Roanoke Rapids. Favorable climatic conditions, abundance of labor, transportation facilities, and potential electric-power resources make this region well suited for future industrial development.

Forest Land - Lumbering was formerly important. The original growth of pines and hardwood, however, has been practically exhausted. The areas which remain under forest cover are predominantly in second growth. Reports of the Department of Agriculture indicate that the forest area of the watershed is comprised of seven per cent old growth, 46 per cent second growth in sawlog sizes, and 47 per cent second growth under sawlog sizes. In view of the concentration of wood-using industries in the watershed, the consumption of existing timber is somewhat greater than the forest growth.

Agriculture - Agriculture accounts for about 56 per cent of the occupational activity of the region. The soil resources of the watershed are devoted chiefly to diversified crops and livestock production. The principal cash crops are tobacco, cotton, and peanuts. Subsistence crops consist of corn, potatoes, small grains, garden, and hay, and are generally raised for local consumption.

Transportation Facilities - Navigable depths in excess of 8 feet are maintained in the lower reaches of the Roanoke River up to Palmyra in Halifax County, 79 miles above the mouth. This navigation project affords water communication with the Atlantic Intracoastal Waterway, connecting parts of the Atlantic Seaboard north and south of the basin. Main and branch lines of the Southern, Norfolk and Western, Atlantic Coast Line, and Seaboard Air Line railway systems serve the basin. A network of Federal and State highways is sufficient for adequate highway transportation throughout the basin.

Climate - The climate of the Roanoke River Basin is temperate. Hot

summers and cold winters are both modified by maritime winds and storms. The humidity is usually high in the Coastal Plain area during the summer months. Light snow and freezing temperatures occur occasionally over the entire basin.

Drought Records - Droughts of great severity in the Roanoke River Basin occurred in 1838-1840, 1930-1932, and 1952-1954. Other droughts occurred in 1755, 1785, 1793, 1806, 1826-1827, 1845, 1879, 1881, 1895, 1925-1926, and 1941.

Precipitation - Maximum, minimum, and average annual rainfall in the Roanoke River Basin is shown in the following table.

TOWN	MAXIMUM	MINIMUM	AVERAGE
Enfield	63.43	30.88	45.27
Henderson	60.11	28.79	46.79
Littleton	56.95	38.89	45.56
Reidsville	56.69	33.22	43.77
Roxboro	56.12	32.16	45.56
Scotland Neck	63.94	32.35	45.16
Weldon	59.58	28.50	45.44
Williamston	55.53	37.89	49.43

General Information Regarding Counties Within or Partially Within the Roanoke River Basin.

Bertie County- A large northern coastal county, Bertie is bounded on three sides by the Roanoke and Chowan Rivers, and has fertile uplands and lowlands with swamps along the southern borders on Roanoke River. Productive woodlands consist of loblolly pine, and black and sweet gum. Bordering on Albemarle Sound, the county also contains the large Chowan, Roanoke, and Cashie Rivers, all navigable.

Tobacco is the chief cash crop, followed by peanuts and corn. Hog raising is important. The soil is good for truck crops. Industrial operations are small with large numbers of logging contractors and sawmills. A modern farm implement and machinery factory is located at Lewiston. The chief marine resources are fresh-water fish.

The numerous navigable waterways of the county offer recreational possibilities, including swimming, fishing, and boating. Fishing for bass, bream, crappie, and pike in the large rivers and numerous creeks is excellent.

Communities include Windsor (county seat), Aulander, Kelford, Woodville, Roxobel, Woodard, Colerain, Powellsville, and Merry Hill.

Rainfall, (inches)	44.86
Snowfall, (inches)	6.7
Mean annual temperature	60.0
Growing season (days)	207
Tobacco (1951 Val.)	$6,625,140
Peanuts (1951 Val.)	$4,882,400
Corn (1951 Val.)	$1,938,330

Total Land Area (acres)	443,520
Forest Area (acres)	302,900
Total Tax Val.	$15,000,000
Tax rate	$1.00

Caswell County - A north Piedmont county, Caswell borders on Virginia. A large deposit of gneissic granite occurs near Pelham, and a large deposit of well-banded gneiss is located on the Yanceyville-Oxford road. Merchantable species of timbers include shortleaf pine and oak. Waters are the Dan River and numerous creeks.

A large part of the land area is in farms, tobacco being the chief crop. The county is the birthplace of bright leaf tobacco. and its cultivation spread throughout the Piedmont region, forming what is known as the Old Bright Belt. Other farm products include corn, vegetables, hay, wheat, hogs, and sweet potatoes. Industrial activity is confined to sawmills, planing mills, and a few textile plants. Hosiery is manufactured at Yanceyville, the county seat.

Other communities include Milton, Ridgeville, Prospect Hill, Pelham, Blanch, Leasburg, Purley, Topnot, Corbett, Gatewood, Fitch, Milesville, and Providence.

Rainfall (inches)	43.86
Snowfall (inches)	11.4
Mean annual temperature	58.9
Growing season (days)	203
Tobacco (1951 Val.)	$8,246,970
Corn (1951 Val.)	$ 778,720
Hay (1951 Val.)	$ 605,770
Total Land Area (acres)	278,720
Forest Area (acres)	109,000
Total Tax Val.	$12,062,860
Tax Rate	$1.75

Forsyth County - An upper Piedmont County, Forsyth has low foothills and fertile plateaus. Merchantable species of trees are shortleaf pine, oak, hickory, and poplar. Waters include the Yadkin River and numerous creeks.

The county is heavily industrialized and agriculturally prosperous. Tobacco is the chief crop, followed by corn and hay. Dairy products are important. The largest employment is in huge factories of the R. J. Reynolds Tobacco Company. The textile industry is large and growing. Other industries include lumbering, and manufacturing of furniture, containers, paperboard products, electrical machinery, radio and radar, and others. Winston-Salem is one of the State's largest tobacco auction centers.

Communities include Winston-Salem (county seat), Kernersville, Rural Hall, Walkertown, Clemmons, Lewisville, Firetown, Pfafftown, Belews Creek, Bethania, Dennis, Tobaccoville, Donaha, Dozier, Williams, Guthrie, Daisy, Mata, and Reynolda.

Rainfall (inches)	44.9
Snowfall (inches)	7.8
Mean annual temperature	59.1
Growing season (days)	197
Tobacco (1942 Val.)	$3,750,000

Hay (1952 Val.)	$ 605,000
Corn (1952 Val.)	$ 710,000
Total Land Area (acres)	271,360
Forest Area (acres)	89,400
Total Tax Val.	$457,694,820
Tax Rate	$.90

Granville County - In the upper Piedmont, Granville is bordered on the north by Virginia. Its land is rolling. The chief merchantable species of timber are pine and oak. The waters in the county are the Tar and Neuse Rivers, and numerous creeks, including Aarons, Beech, Grass, Island, Little Island, Mountain, and Little Mountain Creeks, and part of a small arm of the John H. Kerr Reservoir, in the Roanoke River Basin.

Tobacco, corn, hay, and vegetables are the chief cash crops. Other crops include Irish and sweet potatoes, cotton, and small grains. Dairy products are important. The leading industries are textiles, lumbering, and tobacco manufactures. The largest single employers are a cotton textile mill and a wooden container plant, both at Oxford. There are also planing and plywood mills, four tobacco stemming and redrying plants, two grain mills, and a hosiery plant. There are planing and plywood mills at Creedmoor. Oxford is the tobacco market and manufacturing center. The business of a milk plant in Oxford amounts to approximately $500,000 annually.

A small part of the John H. Kerr Reservoir, affording fishing, swimming, boating, and camping opportunities, lies in the northeastern corner of Granville County.

Communities include Oxford (county seat), Stovall, Stem, Dickerson, Creedmoor, Providence, Clay, Wilton, Northside, Wilkin, Cozart, Berea, Lewis, Gela, Satterwhite, and Bullock.

Rainfall (inches)	44.55
Snowfall (inches	12.2
Mean annual temperaturs	58.8
Growing season (days)	202
Tobacco (1951 Val.)	$12,457,880
Corn (1951 Val.)	$1,061,220
Hay (1951 Val.)	$681,360
Total Land Area (acres)	347,520
Forest Area (acres)	187,400
Total Tax Val.	$36,151,635
Tax Rate	$.90

Halifax County - In the northeast Piedmont and northwest Coastal regions, adjoining the Virginia State line, Halifax is low and rolling. The northern "fall zone" runs through the county. Brick clays occur in several places. The chief merchantable species of timber are loblolly pine, gum, oak, and ash. Waters include the Roanoke River and numerous creeks. Hydroelectric and steam power plants are located at Roanoke Rapids, and Scotland Neck has a municipal steam power plant.

The chief cash crops are tobacco, peanuts, and corn. Hogs and beef cattle are important. The county ranks third among counties of the United States in value of peanuts produced. Other crops include corn, wheat, and

oats. The leading industry is textiles, and the damask mill at Roanoke Rapids is the largest of its kind in the world. Other textile plants include cotton textile mills, a dying and finishing plant, and a hosiery mill. Peanut-processing plants are located at Weldon and Enfield, and Roanoke Rapids has pulp mills. Lumber operations are important. Pine pulpwood, veneers, ties, and pilings are produced.

Shad, rockfish, white perch, bass, carp, and garfish may be caught in the Roanoke River, and shad, perch, and garfish in Fishing Creek. The spring spawning run of striped bass (rockfish) is phenomenal and attracts fishermen and netters from many places throughout the United States.

Communities include Halifax (county seat), Roanoke Rapids, Weldon, Enfield, Scotland Neck, Littleton, Hobgood, and Palmyra.

Rainfall (inches)	44.86
Snowfall (inches)	8.2
Mean annual temperature	61.7
Growing season (days)	203
Tobacco (1951 Val.)	$6,939,890
Peanuts (1951 Val.)	$5,980,400
Cotton (1951 Val.)	$4,660,980
Total Land Area (acres)	462,080
Forest Area (acres)	197,900
Total Tax Val. (est.)	$62,000,000
Tax Rate	$1.00

Martin County - In the coastal region and bordered on the north by the Roanoke River, Martin has a low topography with some swamp lands. A high plateau along the river contains many large, productive farms. The chief merchantable species of trees are loblolly pine, gum, oak, and cypress. Waters include the Roanoke River and Conoho, Sweetwater, Tranters, Crisp, and other creeks.

The leading cash crops are tobacco, peanuts, and corn. Other crops produced are Irish and sweet potatoes, soy beans, hay, and oats. A large pulp plant located at Williamston is supplied with wood from all sections. Livestock raising and dairying are increasing. Other industries at Williamston include four leaf-tobacco warehouses, a tobacco re-drying plant, two peanut plants, a slaughterhouse, a fertilizer plant, and commercial fisheries. Bass, perch, and pike are found in the Roanoke River and in Sweetwater and Conoho Creeks.

Communities include Williamston (county seat), Robersonville, Hamilton, Oak City, Jamesville, Parmele, Everett, Darden, Hassell, Goldpoint, and Beargrass.

Rainfall (inches)	44.86
Snowfall (inches)	6.7
Mean annual temperature	60.7
Growing season (days)	207
Tobacco (1952 Val.)	$11,000,000
Peanuts (1952 Val.)	$ 2,400,000
Corn (1952 Val.)	$ 1,888,000
Total Land Area (acres)	307,840

Forest Area (acres)	174,100
Total Tax Val.	$26,000,000
Tax Rate	$1.35

Northampton County - In the northeast coastal region bordering Virginia, Northampton County has a rolling topography with some swamp land. There are extensive gravel deposits in the northwestern part of the county, particularly along the Roanoke River, and some production of gravel occurs at Garysburg. The principal merchantable species of trees are loblolly pine, gum, poplar, oak, and cypress. Waters include the Roanoke and Meherring Rivers, and Kirby, Potecasi, Catawisky, Uwharrie, and Bridgers Creeks.

Northampton is the largest peanut growing county in the State. Cotton and corn are also important crops. A large hay crop, comprised of peanut vines, is produced, and soybeans are widely grown. Other crops include Irish and sweet potatoes, wheat, oats, and lespedeza. The raising of livestock is increasing. Lumbering is the only large industry, and an increasing demand for pulp in the State has created a market for much of the lumber produced in the county. Wooden containers and morticians' goods are manufactured at Woodland. A shirt factory is located at Rich Square.

Communities include Jackson (county seat), Rich Square, Seaboard, Woodland, Conway, Severn, Garysburg, Milwaukee, George, Lasker, Potecasi, and Pendleton.

Rainfall (inches)	49.24
Snowfall (inches)	7.9
Mean annual temperature	59.5
Growing season (days)	196
Peanuts (1952 Val.)	$5,500,000
Cotton (1952 Val.)	$5,000,000
Hogs (1952 Val.)	$2,500,000
Total Land Area (acres)	345,600
Forest Area (acres)	162,600
Total Tax Val. (1952)	$17,275,281
Tax Rate (1952)	$1.40

Person County - This county lies in the north Piedmont section, with rolling granite hills in the west. Although there is no mineral production in the county, the region is an extension of the Virginia Blue Wing copper district, containing novaculite, a quartz used for whetstones and silver. Building granite is located in the western section. Principal merchantable species of trees are shortleaf pine, oak, red cedar, poplar, and hickory. Streams in the Roanoke River Basin include Hyco River, and North Hyco, South Hyco, Satterfield, Storys, and Marlowe Creeks. Bass are found in Chub Lake, into which Satterfield Creek empties and which forms the source of Storys Creek.

Tobacco is the chief cash crop. Corn and hay are also important. Lespedeza, small grains, and Irish and sweet potatoes are being raised extensively. The growing of livestock and raising of poultry are increasing. Textiles lead the industrial field, the mills producing toweling, upholstery, and drapery fabrics. Other industries include several large lumber-processing plants, a fertilizer-manufacturing plant, a poultry-

processing plant, broom plants, and some food manufactures. A large dairy company manufactures bulk ice cream and furnishes milk.

Communities include Roxboro (county seat), Longhurst, Helena, Woodsdale, Hurdle Mills, Olive Hill, Moriah, Bushy Fork, Cunningham, and Ca-Vel.

Rainfall (inches)	46.09
Snowfall (inches)	11.4
Mean annual temperature	57.8
Tobacco (1951 Val.)	$8,945,780
Corn (1951 Val.)	$853,370
Hay (1951 Val.)	$443,540
Total Land Area (acres)	256,000
Forest Area (acres)	140,000
Tax Rate	$1.10

Rockingham County - In the northern Piedmont section, the topography of Rockingham is rolling. Running through part of the county is a strip of Triassic shales and clays which are utilized by a brick and pipe company at Madison. A seam of coal and carbonaceous shales occurs in this same belt near Stacey (between Wolf Island Creek and Lick Fork Creek in the northeastern section of the county). Principal merchantable species of timber are shortleaf and spruce pine, oak, poplar, and hickory. Waters in the Roanoke River Basin include the Dan and Mayo Rivers, and Hogans, Wolf Island, Rockhouse, and Buffalo Creeks.

Tobacco, corn, and vegetables are the leading crops. Other crops raised include hay, Irish and sweet potatoes, and small grains. The leading industry is textiles, and numerous mills produce a diversified selection of textile products from cotton, silk, wool, and rayon. The large mills of the Marshall Field Company are located in Leaksville, Spray, and Draper in the north central part of the county, and other textile plants are located at Reidsville and Mayodan. Men's and boy's apparel are made at the Washington Mills at Mayodan. Reidsville, the largest town and industrial center of the county (also the largest North Carolina municipality in the Roanoke River Basin), is the site of the American Tobacco Company plant which manufactures Lucky Strike cigarettes. Other industries include lumbering, furniture manufacturing, printing and publishing, food, and chemicals.

Communities, in addition to those mentioned above, include Wentworth (county seat), Stoneville, Ruffin, Oregon Hill, Bethany, and Ellisboro.

Rainfall (inches)	43.86
Snowfall (inches)	11.4
Mean annual temperature	59.7
Growing season (days)	203
Tobacco	$9,296,000
Corn	$729,000
Hay	$182,250
Total Land Area (acres)	366,080
Forest Area (acres)	168,400
Total Tax Val.	$129,800,000
Tax Rate	$.75

Stokes County - In the northwest Piedmont, the topography of Stokes County is high and rolling, and it has a mountain range all its own, the Sauratowns, including Sauratown Mountain, Moores Knob, and Hanging Rock Mountain, named from Indians of that area. Moores Knob, Hanging Rock Mountain, and Hanging Bluff are included in the area of Hanging Rock State Park. The Sauratowns are in the central and west central sections of the county. In the southeastern part of the county is a narrow strip of Triassic sandstone extending through Germanton, Walnut Cove, and Pine Hall. Clays occur in this strip which are suitable for brick and tile. In this same area are seams of coal as well as high carbonaceous shales. Near Sandy Ridge in the northeastern corner of Stokes County is a bed of limestone which was quarried and burned into lime prior to the Civil War. Mica has been found in this section. Chief merchantable species of trees are pine, oak, poplar, and hickory. Waters include the Dan and Little Dan Rivers, and Elk, Peters, Big, Double, Snow, and Town Fork Creeks.

Prinarily an agricultural county, the farmers derive their principal income from tobacco, corn, and vegetables. The latter two crops are used almost entirely on the farms, which also produce fruits, wheat, oats, and livestock. Industries in the county are few. They include the manufacturing of lumber and timber products, stone, clay and glass products, and food and kindred products. One of the largest manufacturers of face brick and clay in the State is located at Pine Hall.

Hanging Rock State Park is four miles from Danbury, 14 miles from Walnut Cove, and 32 miles from Winston-Salem. It is accessible over paved highways from North Carolina Highways 89 and 66. It offers a variety of features, both natural and man-made, that afford interest and pleasure. Rugged mountain terrain, clear sparkling mountain streams, waterfalls and cascades, a cool inviting lake nestled in the hills, extensive growths of laurel, rhododendron, stewartia, and other flowering shrubs, and beautiful interior and distant views - all these await the visitor. From Moore's Knob elevation 2,572 feet, one may look across the valley of the Dan River, with its patchwork of tobacco fields, to the Blue Ridge mountains of North Carolina and Virginia. From Hanging Rock, miles of the upper portion of the Piedmont Plateau are spread out before the eye. Swimming facilities consist of a bath house and lake with a sand beach and a protected water area. Boats are available for rent. Bass and panfish may be caught in the lake.

Communities in Stokes County include Danbury (county seat), Walnut Cove, King, Pinnacle, Pine Hall, Germanton, and Sandy Ridge.

Rainfall (inches)	45.58
Snowfall (inches)	12.1
Mean annual temperature	56.9
Growing season (days)	182
Tobacco (1951 Val.)	$8,839,680
Corn (1951 Val.)	$874,190
Hay (1951 Val.)	$567,380
Total Land Area (acres)	293,760
Forest Area (acres)	151,300
Total Tax Val.	$16,281,254
Tax Rate	$1.50

Vance County - Vance, in the northeast Piedmont, bordering Virginia, has the characteristic rolling terrain of this section, with an altitude of around 500 feet. Largely agricultural, it is more akin to the Coastal Plain in its economy than it is to its Piedmont neighbors to the southeast. The county has large reserves of granite, which have been quarried for many years, being used for paving blocks, copings, and to some extent for building. In recent years, a sensational field of tungsten embedded in granite has been discovered, and substantial operations have resulted therefrom. Some 300 tons of ore are produced daily, with an annual output valued at $1,000,000. It is the largest tungsten-producing field in North America. The forests have been well cut over, and most of those remaining are farm woodlands. Waters in the Roanoke River Basin include a large arm of the John H. Kerr Reservoir (15,940 acres) in the northeastern part of the county, part of which is in Granville County, and Little, Flat, Crooked, Nutbush, and Anderson Swamp Creeks. Part of the marginal lands bordering on the large arm (15,940 acres)are included in the Nutbush Conservation Area, leased by the Corps of Engineers, U. S. Army, to the North Carolina Board of Conservation and Development, and managed by the Kerr Reservoir Development Commission, a State agency responsible for development of the Nutbush Conservation Area for recreational purposes.

About seventy percent of the farm income is derived from field crops, with the principal crop in tobacco. Corn and hay are also important. Industry is almost entirely concentrated in Henderson, county seat, with most of the industrially-employed people being engaged in textile work. There are also tobacco-redrying plants, sawmills, and a heavy-duty truck manufactory. Henderson is a bustling tobacco-auction market.

Communities in addition to Henderson include Greystone, Townsville, Middleburg, and Kittrell. Henderson, Greystone, and Middleburg, on the main line of the Seaboard Air Line Railway, are located on the boundary between the Roanoke and Tar River Basins. Townsville, in the northern part of the county, is located in the Roanoke River Basin, and Kittrell, in the southern part of the county, is situated in the Tar River Basin.

Rainfall (inches)	46.57
Snowfall (inches)	10.6
Mean annual temperature	59.2
Growing season (days)	209
Tobacco (1951 Val.)	$8,552,750
Corn (1951 Val.)	$601.620
Cotton (1951 Val.)	$602,950
Total Land Area (acres)	172,160
Forest Area (acres)	71,100
Total Tax Val.	$34,000,000
Tax Rate	$1.10

Warren County - In the northeast Piedmont, Warren County is characterized by the rolling topography of the central plains. Chief merchantable species of trees in the county are loblolly and shortleaf pine, oak, poplar, hickory, and gum. The Roanoke River crosses the northeast corner of the county. A small part of an arm of the John H. Kerr Reservoir is located in the northwest corner of the county. Other waters in the Roanoke River Basin include Smith, Terrapin, Hawtree, Six Pond, Hubquarter, and Big Stonehouse Creeks.

The diversified farming in Warren County includes, in addition to tobacco, cotton, and corn, which are the chief crops, small grains, cantaloupes, cucumbers, peanuts, sweet and Irish potatoes, wheat, oats, and soybeans. This county is the largest producer of pickling cucumbers in the State. Lumbering is the major industry in the county, with textiles ranking second. There are forty-three grade A dairies in the county.

Rainfall (inches)	46.47
Snowfall (inches)	10.6
Mean annual temperature	59.2
Growing season (days)	209
Tobacco (1952 Val.)	$5,775,000
Cotton (1952 Val.)	$1,870,000
Livestock (1952 Val.)	$750,000
Total Land Area (acres)	283,500
Forest Area (acres)	148,500
Total Tax Val. (1952)	$15,191,980
Tax Rate (1952)	$1.28

Washington County - In the northeast coastal area, Washington is low and sandy with some fertile black land. Sixty-five per cent of the area is in swampland, and over half is in forest. The timber, mostly loblolly and gum, grows on the higher or best-drained land. Savanna or pocosin pine is usually found in the swamps. There is no mineral production. Industrialists in recent years, however, have been investigating the possibility of recovering ilmenite from black sands in Albemarle Sound for use in paints and pigments. Shell limestone or marl and clay deposits, suitable for brickmaking, occur in the county. Waters in the Roanoke River Basin include the Roanoke River, and Welch and Conaby Creeks.

Most of the farming is confined to the northern part of the county. Peanuts, tobacco, soybeans, potatoes, and corn occupy most of the acreage. Important livestock and farming demonstrations are conducted at the Federal-State Tidewater Test Farm, five miles from Plymouth, county seat. There is some commercial grape culture. Commercial fishing is still pursued to some extent though much reduced, since the herring run has diminished, a situation said to be due to the pollution of the Roanoke River. Oyster and other shellfish culture is being developed. Wood-using industries are markedly predominant in the county. Although the huge North Carolina Pulp Company's plant is across the Martin County line, it is regarded as a Plymouth enterprise, and most of the workers live in Plymouth. The Company owns and manages 150,000 acres of reserve timberland. In addition to this plant, there are plywood (one of the largest plywood plants in the United States), a box container, and fork and hoe, manufacturers, all in Plymouth. There are also large sawmills at Rober (Mackeys Creek Basin) and Creswell (Scuppernong River Basin), and numerous smaller plants in various parts of the county. The supplying of the factories with raw material has led to extensive logging operations. Timber from adjoining counties and other points is brought to Plymouth by raft, barge, truck, and rail. The Roanoke River here is navigable and finished pulp is boated all the way to the Great Lakes via inland waterways.

Pettigrew State Park is located on the shore of State-owned Lake Phelps, a 16,600 acre lake, second largest natural lake in the State. Most

of the lake is in the southeast section of Washington County, and a small part of the lake is in Tyrell County. Five canals, from about five to about eight miles long, drain the land between Lake Phelps and the Scuppernong River, forming Scuppernong Farms.

The park is nine miles from U. S. Highway 64 at Creswell. Lake Phelps adds greatly to the natural beauty of the park. A magnificent cypress growth along the lake shore is not the least of the attractions that await the visitor. These great old trees, which have seen the rise and decline of the large plantations, form a most attractive setting for the lake, which has long been an angler's paradise. Black bass and pan fish abound in the lake. Row boats are available for rent, and the park facilities include a boat pier and launching site for boats. Due to the growth of vegetation in the water, swimming is not desirable. There are plans to develop overnight accommodations at the park. Boating and swimming are available at Albemarle Beach near the Town of Mackeys and at several other beaches on Albemarle Sound.

Communities other than those mentioned above include Hoke, Hinson, Westover, Pleasant Grove, Beasley, Skinnerville, and Scuppernong.

Rainfall (inches)	51.15
Snowfall (inches)	6.0
Mean annual temperature	60.2
Growing season (days)	184
Tobacco (1952 Val.)	$976,313
Peanuts (1952 Val.)	$590,433
Corn (1952 Val.)	$504,310
Total Land Area (acres)	215,040
Forest Area (acres)	152,500
Total Tax Val.	$10,869,098
Tax Rate	$1.70

Watershed Boundary - The boundary line of the Roanoke River Basin in North Carolina, in a clockwise direction, extends generally as follows:

Beginning at Albemarle Beach on Albemarle Sound 1½ miles west of the Town of Mackeys;

Thence one mile south along an unnumbered highway to N. C. Highway 32;

Thence southwest along N. C. Highway No. 32 to the Town of Westover;

Thence in a generally southwesterly direction to a point on the Washington-Beaufort County line about four miles east of Welch Creek;

Thence southwest and west in Beaufort County to a point on the Martin-Beaufort County line about 1½ miles southwest of Welch Creek;

Thence southwest and northwest along the Martin-Beaufort County line to a point thereon about 1½ miles northwest of the intersection of U. S. Highway 17 with that line;

Thence in a generally northwesterly direction to the junction of N.C. Highways 44 and 125, passing near the Towns of Beargrass and Everetts;

Thence west on N. C. Highway No. 44 to the Edgecombe-Martin County line;

Thence northwest along the Edgecombe-Martin County line to the change in direction of this line from northwest to northeast about three miles northwest of the Town of Speed in Edgecombe County;

Thence in Edgecombe County generally parallel to Etheridge Creek to a point on the Halifax-Edgecombe county line about half way between Fishing Creek and Etheridge Creek;

Thence north in Halifax County generally along U. S. Highway 258 to a point about ½ mile northeast of the Village of Roseneath;

Thence northwest and west generally parallel to Beech Swamp, to a point on N. C. Highway 481 about three miles east of Enfield;

Thence north generally along U. S. Highway 301 to a point about 3 miles south of Halifax;

Thence northwest generally parallel to Quankey Creek to a point about 2½ miles west of Rheasville;

Thence west about five miles to the intersection of two unnumbered highways 1.4 miles south of Roper Springs;

Thence north 1.4 miles to Roper Springs, and two miles west from Roper Springs to Littleton, along an unnumbered highway;

Thence in Warren County generally along U. S. Highway 158 and the Seaboard Air Line Railway through Vaughan, Warren Plains, Norlina, and Ridgeway to Manson;

Thence in Vance County generally along U. S. Highway 1 and 158, and the Seaboard Air Line Railway through Middleburg and Greystone to Henderson;

Thence along the Southern Railway through Dabney to a point on the Vance-Granville County line about one mile west of Dabney;

Thence northwest and west in Granville County to a point on U. S. Highway 15 about 0.5 mile north of Lewis:

Thence generally southwest to Kinston Fork;

Thence northwest along N. C. Highway 96 about 3½ miles to a point one mile east of Satterwhite;

Thence west, northwest, and west about 8.5 miles along a stone-surfaced unnumbered highway to a point on the Granville-Person County line about three miles northwest of Goshen;

Thence west in Person County along a county road about 2.5 miles;

Thence generally south about 2.5 miles to the source of the Tar River about two miles southeast of Allensville;

Thence generally west about seven miles to Roxboro;

Thence southwest along N. C. Highway 49 to Gordonton;

Thence south 2.5 miles to a point on the Person-Orange County line about one mile east of the Person-Caswell County line;

Thence south about one mile and southwest about two miles, in Orange County to a point on N. C. Highway 86 about two miles southeast of the junction of N. C. Highways 49 and 86;

Thence northwest on N. C. Highway 86 to that junction;

Thence southwest along N. C. Highway 49 to a point on the Alamance-Orange County line about 3½ miles south of the northwest corner of Orange County;

Thence generally northwest in Alamance County to a point on the Caswell-Alamance County line about two miles west of the northeast corner of Alamance County;

Thence northwest in Caswell County about two miles to Baynes;

Thence along an unnumbered highway through Anderson and Jericho to Camp Springs;

Thence west about two miles to a point on the Rockingham-Caswell County line about three miles north of the southwestern corner of Caswell County;

Thence in Rockingham County generally along N. C. Highway 87 to Reidsville;

Thence along N. C. Highway 65 through Bethany to Stokesdale in Guilford County;

Thence two miles south on N. C. Highway 68 to its intersection with an unnumbered highway;

Thence southwest along that highway to a point on the Guilford-Forsyth County line about five miles south of the northwestern corner of Guilford County;

Thence in Forsyth County south along an unnumbered highway to its junction with N. C. Highway 150;

Thence along N. C. Highway 150 to Kernersville;

Thence northwest along N. C. Highway 66 to Staleyville;

Thence north along U, S. Highway 52 and N. C. Highway 66 to Rural Hall;

Thence northwest and north along N. C. Highway 66 through Poplar Springs, Mt. Olive, and Boyles Chapel to the Village of Gap in Stokes County;

Thence west to Sauratown Mountain and generally northwest to Westfield in Surry County;

Thence northwest along N. C. Highway 89 to a point thereon 1.7 miles northwest of Woodville;

Thence north to the North Carolina-Virginia State line at a point about four miles west of the northeastern corner of Surry County;

Thence east along the North Carolina-Virginia State line along the northern boundaries of Stokes, Rockingham, Caswell, Person, Granville, Vance, Warren, Halifax, and Northampton Counties to a point on the State line about three miles northwest of Gaston;

Thence in Northampton County in a generally southeasterly direction to the intersection of an unnumbered highway and N. C. Highway 195 about 2.5 miles southwest of the town of Seaboard;

Thence generally southeast, south, and southeast along that unnumbered highway through Jackson, Boones X-Roads, and Bryantown to the Town of Rich Square;

Thence east and southeast generally along N. C. Highway 305 through Mintons Store, and Aulander to the town of Connaritsa in Bertie County;

Thence southeast along the ridge between Connaritsa Swamp and Wildcat Swamp to the Town of Askewville;

Thence northeast to the intersection of two unnumbered highways about one mile south of Perrytown; and

Thence along that ridge and along the ridge between Cashote Creek and Black Swamp to a point on the shore of Albemarle Sound about two miles northeast of the mouth of Cashote Creek.

Roanoke River Basin Streams - There follows a list, alphabetically arranged, of streams in the Roanoke River Basin in North Carolina, the names of which are shown on available maps. There are a great number of streams on such maps, the names of which are not indicated. There are shown on the following list the streams into which each of the streams, alphabetically placed on the list, flows, and also the county in which the junction of the corresponding two streams is located. It is believed that this list will be helpful to interested persons in quickly locating, on a county, topographical or other map, any stream included in the list and also to trace the course of the stream throughout the basin.

STREAM	RECEIVING STREAM	COUNTY IN WHICH JUNCTION OCCURS
Aarons Creek (Granville)	Dan River	Mecklenberg (Va.)
Anderson Swamp Creek	Roanoke River	Vance
Archies Creek	Dan River	Stokes
Arthurs Creek	Roanoke River	Northampton
Bagley Academy Branch	Little Stonehouse Creek	Warren
Banner Branch	Snow Creek	Stokes
Bearskin Creek	Grass Creek	Granville
Beaverdam Creek	Conoho Creek	Martin
Beaver Island Creek	Dan River	Rockingham
Beech Creek	Grass Creek	Granville
Belews Creek	Dan River	Stokes

STREAM	RECEIVING STREAM	COUNTY IN WHICH JUNCTION OCCURS
Big Creek	Dan River	Stokes
Big Stonehouse Creek	Roanoke River	Warren-Northampton
Birch Fork Creek	Wolf Island Creek	Rockingham
Black Gut Creek	Roanoke River	Northampton
Blue Creek	Little Grass Creek	Granville
Blue Mud Creek	Smith Creek	Warren
Blue Wing Creek (Person)	Hyco River	Halifax (Va.)
Boaz Creek	Mayo River	Rockingham
Bridgers Creek	Roanoke River	Northampton
Brittons Swamp	Roanoke River	Bertie
Broad Creek	Cashie River	Bertie
Broad Creek	Roanoke River	Bertie
Brushy Creek	Town Fork Creek	Stokes
Buffalo Creek	Town Fork Creek	Stokes
Buffalo Creek	Mayo River	Rockingham
Buffalo Creek	Dan River	Rockingham
Burkes Creek	Penson Creek	Caswell
Camp Creek	Cascade Creek	Stokes
Canal Gut	Roanoke River	Bertie
Cane Creek	Hyco River	Person
Cascade Creek	Dan River	Rockingham
Cashie River	Batchelor Bay	Bertie
Cashote Creek	Roanoke River	Bertie
Castle Creek	Hyco River	Person
Chiska Creek	Cashie River	Bertie
Chockoyotte Creek	Roanoke River	Halifax
Choowatic Creek	Roquist Creek	Bertie
Chucklemaker Swamp	Hoggard Mill Creek	Bertie
Cobbs Creek	Hyco Creek	Caswell
Conaby Creek	Roanoke River	Washington
Conine Creek	Roanoke River	Bertie
Coniott Creek	Roanoke River	Bertie
Connaritsa Swamp	Cashie River	Bertie
Conoconnara Swamp	Roanoke River	Halifax
Conoho Creek	Roanoke River	Martin
Cooper Swamp	Gardners Creek	Martin
Country Line Creek (Caswell)	Dan River	Halifax (Va.)
Crooked Creek	South Mayo River	Rockingham
Crooked Fork	Aarons Creek	Granville
Crooked Run	Nutbush Creek	Vance
Deep Creek	Roanoke River	Halifax
Deep Creek	Roanoke River	Northampton
Deep Run Swamp	Gardners Creek	Martin
Devils Gut	Roanoke River	Martin
Dog Branch	Sweetwater Creek	Martin
Dogwood Branch	Pea Hill Creek	Northampton
Donaldson Creek	Maho Creek	Person
Double Branch	Black Gut Creek	Northampton
Dry Branch	Cascade Creek	Rockingham
Dry Creek	Dan River	Rockingham
Duck Creek	South Hyco Creek	Person
East Belews Creek	Belews Creek	Forsyth
E. Prong Jacobs Creek	Jacobs Creek	Rockingham
E. Prong Moon Creek	Moon Creek	Caswell
Elk Creek	Dan River	Stokes
Etheridge Creek	Etheridge Swamp	Halifax

STREAMS	RECEIVING STREAM	COUNTY IN WHICH JUNCTION OCCURS
Etheridge Swamp	Conoho Creek	Martin
Eurins Creek	Dan River	Stokes
Fishing Branch	Marlowe Creek	Person
Flag Run	Roanoke River	Bertie
Flat Creek	Nutbush Creek	Vance
Flat Shoal Creek	Dan River	Stokes
Flat Swamp	Hoggard Mill Creek	Bertie
Foggs Creek	Dan River	Stokes
Fulk Creek	Dan River	Stokes
Fullers Creek	Moon Creek	Caswell
Fulp Creek	Redbank Creek	Stokes
Gardners Creek	Devils Gut	Martin
Ghents Creek	Hyco River	Person
Goose Neck Creek	Jonathan Creek	Granville
Graham Branch	Little Grass Creek	Granville
Grass Creek (Granville)	Roanoke River	Mecklenberg (Va.)
Gumberry Swamp	Wheeler Creek	Northampton
Hardison Mill Creek	Sweetwater Creek	Martin
Hawtree Creek (Warren)	Roanoke River	Mecklenberg (Va.)
Hickory Creek	Mayo River	Rockingham
Hogans Creek	Dan River	Rockingham
Hoggard Mill Creek	Cashie River	Bertie
Hostler Branch	Country Line Creek	Caswell
Howlett Creek	Little Island Creek	Granville
Hubquarter Creek	Roanoke River	Warren
Hyco Creek	Hyco River	Person
Hyco River (Person)	Roanoke River	Halifax (Va.)
Indian Creek	Cascade Creek	Stokes
Indian Creek	Nutbush Creek	Vance
Indian Creek	Roanoke River	Bertie
Island Creek	Dan River	Caswell
Island Creek	Dan River	Rockingham
Island Creek (Granville)	Roanoke River	Mecklenberg (Va.)
Jacobs Creek	Dan River	Rockingham
Jimmies Run	Roanoke River	Northampton
Johnsons Creek	Grass Creek	Granville
Jonathan Creek (Granville)	Roanoke River	Mecklenberg (Va.)
Jones Creek	Hogans Creek	Rockingham
Jordans Creek	Six Pound Creek	Warren
Kehukee Swamp	Roanoke River	Halifax
Lanier Swamp	Gardners Creek	Martin
Lees Creek	Deep Creek	Northampton
Left Fork Belews Creek	Belews Creek	Forsyth
Left Prong Foggs Creek	Foggs Creek	Stokes
Lick Creek	Town Fork Creek	Stokes
Lick Fork Creek	Hogans Creek	Caswell
Lilly Pond Creek	Wheeler Creek	Northampton
Little Creek	Dan River	Stokes
Little Deep Creek	Deep Creek	Halifax
Little Grass Creek	Grass Creek	Granville
Little Hubquarter Creek	Hubquarter Creek	Warren
Little Island Creek	Island Creek	Granville
Little Matrimony Creek	Matrimony Creek	Rockingham
Little Neatmans Creek	Neatmans Creek	Stokes
Little Quankey Creek	Quankey Creek	Halifax
Little Sandy Branch	Town Fork Creek	Stokes

STREAMS	RECEIVING STREAM	COUNTY IN WHICH JUNCTION OCCURS
Little Snow Creek	Snow Creek	Stokes
Little Stone House Creek	Big Stone House Creek	Warren
Lizzards Creek	Roanoke River	Northampton
Long Creek	Hardison Mill Creek	Martin
Lovelace Creek	Wolf Island Creek	Rockingham
Lynch Creek	Hyco Creek	Caswell
Maho Creek (Person)	Dan River	Halifax (Va.)
Malones Creek	Blue Mud Creek	Warren
Marlowe Creek	Storys Creek	Person
Martin Creek	Town Fork Creek	Stokes
Matrimony Creek	Dan River	Rockingham
Mayo River	Dan River	Rockingham
Meadow Branch	Pinch Gut Creek	Stokes
Middle River	Batchelor Bay	Bertie
Mill Branch	Conoho Creek	Martin
Mill Creek	Anderson Swamp Creek	Vance
Mill Creek	Hawtree Creek	Warren
Mill Creek	Maho Creek	Person
Mill Creek	South Hyco Creek	Person
Mill Swamp	Roquist Creek	Bertie
Mills Creek	Town Fork Creek	Stokes
Mitchell Creek	Marlowe Creek	Person
Moon Creek	Dan River	Caswell
Mossy Creek	Dan River	Rockingham
Mountain Branch	Snow Creek	Stokes
Mountain Creek	Grass Creek	Granville
Neatmans Creek	Town Fork Creek	Stokes
North Double Creek	Dan River	Stokes
North Fork	Rattlesnake Creek	Caswell
Nutbush Creek (Vance)	Roanoke River	Mecklenberg (Va.)
Occoneechee Creek	Roanoke River	Northampton
Panther Branch	Hyco Creek	Caswell
Paw Paw Creek	Mayo River	Rockingham
Pea Hill Creek	Roanoke River	Northampton
Penson Creek	South Country Line Creek	Caswell
Peters Creek	Dan River	Stokes
Pinch Gut Creek	Big Creek	Stokes
Poplar Branch	Matrimony Creek	Rockingham
Quaqua Creek	Wolf Island Creek	Rockingham
Quankey Creek	Roanoke River	Halifax
Quinine Swamp	Roanoke River	Bertie
Racoon Creek	Snow Creek	Stokes
Rattlesnake Creek	Dan River	Caswell
Ready Branch	Sweetwater Creek	Martin
Redbank Creek	Town Fork Creek	Stokes
Reed Creek	Dan River	Rockingham
Reedy Fork Creek	Hyco Creek	Caswell
Richland Creek	South Hyco Creek	Person
Right Fork	Belews Creek	Forsyth
Right Prong	Lick Creek	Stokes
Roach Creek	Dan River	Rockingham
Roanoke River	Batchelor Bay	Bertie-Washington
Rock House Creek	Dan River	Rockingham
Roquist Creek	Cashie Creek	Bertie
Sandy Branch	Town Fork Creek	Stokes
Sandy Run	Roanoke River	Bertie-Northampton

STREAM	RECEIVING STREAM	COUNTY IN WHICH JUNCTION OCCURS
Satterfield Creek	Storys Creek	Person
Sauls Creek	Hawtree Creek	Warren
Six Pound Creek (Warren)	Roanoke River	Brunswick (Va.)
Smith Creek (Warren)	Roanoke River	Mecklenberg (Va.)
Smithwick Creek	Sweetwater Creek	Martin
Snipe Creek	Mill Creek	Person
Snow Creek	Dan River	Stokes
South Country Line Creek	Country Line Creek	Caswell
South Double Creek	Dan River	Stokes
South Fork	Rattlesnake Creek	Caswell
South Hyco Creek	Hyco River	Person
South Mayo River	Mayo River	Rockingham
South Prong	Crooked Creek	Stokes
Spewmarrow Creek	Grass Creek	Granville
Spoonwater Creek	Maho Creek	Person
Steadmans Creek	Dan River	Stokes
Storys Creek	Hyco River	Person
Sugar Tree Creek	South Hyco Creek	Person
Sweetwater Creek	Roanoke River	Martin
Terrapin Creek	Smith Creek	Warren
Thompsons Gut	Roanoke River	Bertie
Town Creek	Dan River	Rockingham
Town Fork Creek	Dan River	Stokes
Trickum Creek	Buffalo Creek	Stokes
Wading Place Creek	Cashie River	Bertie
Wahtom Swamp	Cashie River	Bertie
Walker Creek	Roanoke River	Warren
Watts Creek	Town Fork Creek	Stokes
Webb Mill Branch	Keehukee Swamp	Halifax
West Belews Creek	Belews Creek	Stokes
West Branch	Malones Creek	Warren
West Fork	Sandy Branch	Stokes
West Littleton Branch	Little Stone House Creek	Warren
West Prong	Beaver Island Creek	Rockingham
West Prong	Hogans Creek	Rockingham
West Prong	Jacobs Creek	Rockingham
Wheeler Creek	Roanoke River	Northampton
Whetstone Creek	Dan River	Rockingham
Whiteoak Creek (Rockingham)	Dan River	Pittsylvania (Va.)
Whiteoak Swamp	Cashie River	Bertie
Williamson Creek	Dan River	Rockingham
Wolf Island Creek	Dan River	Caswell
Zilphy Creek	Dan River	Stokes

Descriptions and Chemical Character of Public Water Supplies - "Progress Report No. 1, Public Surface-Water Supplies in North Carolina, U. S. Geological Survey, Raleigh, 1947", prepared in cooperation with the State Board of Health, contains the following information regarding public surface-water supplies in the Roanoke River Basin. Ownership is municipal unless otherwise indicated.

Leaksville, Rockingham County

Population, 1940 - 1,886 (Population, 1950 - 4,045)
Supplies also about 1,000 people outside of city limits.
Source - Dan River
Treatment - Coagulation with alum and soda ash, chlorine, rapid sand filtration, final adjustment of pH with soda ash.

Sample collected - June 12, 1946		Sodium and potassium	20
Color	3	Bicarbonate	46
pH	7.8	Sulfate	16
Silica	13	Chloride	2.5
Iron	.03	Fluoride	0.1
Manganese	0.0	Nitrate	0.1
Calcium	3.3	Dissolved solids	79
Magnesium	1.4	Total hardness	14

Mayodan, Rockingham County

Population, 1940 - 2,323 (Population, 1950 - 2,246)
Supplies also about 1,500 people outside of city limits
Ownership - Washington Mills Company
Source - Mayo River
Treatment - Coagulation with alum and soda ash, chlorine, rapid sand filtration, final adjustment of pH with soda ash

Sample collected - July 13, 1946		Sodium and potassium	12
Color	2	Bicarbonate	34
pH	7.7	Sulfate	9.3
Silica	15	Chloride	1.5
Iron	0.02	Fluoride	0.1
Manganese	0.0	Nitrate	0.5
Calcium	3.5	Dissolved solids	58
Magnesium	1.4	Total hardness	14

Reidsville, Rockingham County

Population, 1940 - 10,387 (Population, 1950 - 11,708)
Supplies also about 300 people outside of city limits
Source - Big Troublesome Creek
Treatment - Coagulation with alum and lime, rapid sand filtration, chlorine, final adjustment of pH with lime

Sample collected - January 25, 1946		Sodium and potassium	3.2
Color	2	Bicarbonate	30
Silica	13	Sulfate	19
Iron	.22	Chloride	2.5
Manganese	.0	Nitrate	.3
Calcium	13	Dissolved solids	71
Magnesium	2.3	Total hardness	42

Roanoke Rapids, Halifax County

Population, 1940 - 8,545 (Population, 1950 - 8,156)
Supplies also about 550 people outside of city limits.
Source - Roanoke River
Treatment - Coagulation with alum and soda ash, ammonia, chlorine, final adjustment of pH with soda ash.

Sample collected - March 18, 1946		Sodium and potassium	14
Color	2	Bicarbonate	113
pH	7.9	Sulfate	3.8
Silica	12	Chloride	3.0
Iron	0.2	Fluoride	.2
Manganese	.0	Nitrate	.8
Calcium	20	Dissolved solids	138
Magnesium	5.4	Total hardness	72

Roxboro, Person County

Population, 1940 - 4,599 (Population, 1950 - 4,321)
Supplies also about 125 people outside of city limits, Brooksdale (about 85), Longhurst (about 600), and Cavel (about 1,300).
Sources - Stony Creek and Satterfield Creek impounded in City Lake.
Treatment - Coagulation with alum, chlorine, rapid sand filtration, final adjustment of pH with soda ash.

Sample collected - April 24, 1946		Sodium and potassium	21
Color	4	Bicarbonate	53
pH	7.9	Sulfate	12
Silica	9.5	Chloride	4.1
Iron	.12	Fluoride	.0
Manganese	.0	Nitrate	.3
Calcium	3.9	Dissolved solids	83
Magnesium	1.5	Total hardness	16

Weldon, Halifax County

Population, 1940 - 2,341 (Population, 1950 - 2,295)
Supplies also about 200 people outside of city limits
Source - Roanoke River
Treatment - Coagulation with alum, chlorine, rapid sand filtration, calgon, chlorine, final adjustment of pH with soda ash.

Sample collected - July 11, 1946		Sodium and potassium	17
Color	8	Bicarbonate	38
pH	7.9	Sulfate	23
Silica	12	Chlorine	4.5
Iron	.10	Fluoride	.1
Manganese	.0	Nitrate	.5
Calcium	6.5	Dissolved solids	85
Magnesium	2.3	Total hardness	26

The following material is taken from "Progress Report No. 2, Public Ground-Water Supplies in North Carolina, U. S. Geological Survey, Raleigh, 1949", prepared in cooperation with the North Carolina State Board of Health. Ownership is municipal unless otherwise indicated.

Halifax, Halifax County

Population 1940 - 374 (Population, 1950 - 346)

Halifax, Halifax County (continued)

Source	Well 1	Well 2
Depth of well (ft.)	50	50
Diam. of well (in.)	6	6
Yield (g.p.m.	50	50
Sample collected	Mar. 21, 1947	Mar. 21, 1947
Treatment	none	none
Color	0	0
pH	5.1	4.8
Silica	22	10
Iron	.08	.09
Manganese	.00	.00
Calcium	4.6	2.3
Magnesium	1.9	1.8
Sodium and potassium	14	11
Bicarbonate	6	3
Sulfate	7.1	.7
Chloride	17	16
Fluoride	.0	.0
Nitrate	17	13
Dissolved solids	98	68
Total hardness	19	13

Jackson, Northampton County

Population, 1940 - 1,200 (Population, 1950 - 1,173)

Source	Well 1	Well 2	Well 3	Well 4	Well 5
Depth (ft.)	28	28	28	40	260
Diameter (in.)	2	2	2	6	9
Yield (g.p.m.)	8	8	8	15	15
Sample collected	3-24-47	3-24-47	3-24-47	3-24-47	3-24-47
Treatment	Caustic Soda	Caustic Soca	Caustic Soda	Caustic Soda	none
Color	3	2	0	3	2
pH	5.1	5.0	5.1	5.6	8.0
Silica	6.8	6.6	7.1	11	13
Iron	.34	.24	.16	.10	.17
Manganese	.00	.00	.00	.00	.00
Calcium	.9	.8	.8	4.0	3.8
Magnesium	.6	.6	.5	.7	3.6
Na + K	9.0	7.2	7.3	7.6	106
Bicarbonate	4	4	4	12	220
Sulfate	.9	.6	.8	1.1	14
Chloride	6.2	5.2	5.5	5.1	41
Fluoride	.0	.0	.0	.0	.5
Nitrate	14	11	10	14	.0
Dissolved solids	41	35	36	54	297
Total hardness	5	4	4	13	24

Littleton, Halifax and Warren Counties

Population, 1940 - 1,200 (Population, 1950 - 1,173)

Source	Well	Calcium	25
Depth (ft.)	358	Magnesium	4.4
Diameter (in.)	8	Na + K	13

Littleton (continued)

Yield (g.p.m.)	75	Bicarbonate	98
Sample collected	3-26-47	Sulfate	15
Treatment	none	Chloride	7.2
Color	4	Fluoride	1.3
pH	7.4	Nitrate	.2
Silica	31	Dissolved solids	147
Iron	.18	Total hardness	80
Manganese	.00		

Milton, Caswell County

Population, 1940 - 329 (population, 1950 - 317)

Source	Well	Calcium	45
Depth (ft.)	300	Magnesium	8.3
Diameter (in.)	4.5	Na + K	15
Yield (g.p.m.)	25	Bicarbonate	155
Sample collected	2-18-48	Sulfate	18
Treatment	none	Chloride	24
Color	3	Fluoride	.1
pH	7.2	Nitrate	.1
Silica	33	Dissolved solids	228
Iron	1.4	Total hardness	146
Manganese	.18		

Moores Springs, Stokes County

Population, 1940 - 14 (est.)
Ownership - W. G. Petree

Source	Spring	Calcium	404
Depth (ft.)	- -	Magnesium	39
Diameter (in.)	- -	Na + K	15
Yield (g.p.m.)	- -	Bicarbonate	84
Sample collected	3-28-47	Sulfate	1080
Treatment	none	Chloride	4.0
Color	3	Fluoride	1.0
pH	7.3	Nitrate	.0
Silica	18	Dissolved solids	1770
Iron	1.5	Total hardness	1170
Manganese	.10		

Norlina, Warren County

Population, 1940 - 794 (Population, 1950 - 874)

Source	Well	
Depth (ft.)	52	
Diameter (in.)	6	
Yield (g.p.m.)	45	
Sample collected	6-30-49 (raw water,	6-30-49 (treated water)
Treatment	Chlorination	
Color	1	4
pH	5.5	5.4
Silica	13	12
Iron	.05	.06
Manganese	.00	.00
Calcium	3.8	4.0

Norlina, Warren County (continued)

	6-30-49 (raw water),	6-30-49 (treated water)
Magnesium	1.4	1.3
Na + K	17	18
Bicarbonate	10	10
Sulfate	2.4	1.7
Chloride	24	25
Fluoride	.0	.1
Nitrate	10	10
Dissolved solids	85	15
Total hardness	86	15

Plymouth, Washington County

Population, 1940 - 2,461 (Population, 1950 - 4,486)

Source	Well	Calcium	45
Depth (ft.)	155	Magnesium	25
Diameter (in.)	10	Na + K	221
Yield (g.p.m.)	500	Bicarbonate	374
Sample collected	6-11-46	Sulfate	32
Treatment	none	Chloride	250
Color	7	Fluoride	.5
pH	7.3	Nitrate	1.8
Silica	36	Dissolved solids	812
Iron	.12	Total hardness	215
Manganese	.00		

Rich Square, Northampton County

Population, 1940 - 942 (Population, 1950 - 971)

Source	Well	Calcium	2.1
Depth (ft.)	85	Magnesium	1.0
Diameter (in.)	6	Na + K	5.3
Yield (g.p.m.)	150	Bicarbonate	17
Sample collected	8-24-48	Sulfate	1.9
Treatment	none	Chloride	2.4
Color	2	Fluoride	.0
pH	6.3	Nitrate	2.0
Silica	24	Dissolved solids	51
Iron	.08	Total hardness	9
Manganese	.00		

Scotland Neck, Halifax County

Population, 1940 - 2,559 (Population, 1950 - 2,730)

Source	Well 1	Well 2	Well 3	Well 4
Depth (ft.)	75	75	75	75
Diameter (in.)	8	8	8	8
Yield (g.p.m.)	150	150	160	50
Sample collected	1-31-49	1-31-49	1-31-49	1-31-49
Treatment	none	none	none	none
Color	2	2	2	2
pH	6.2	6.6	5.5	5.6
Silica	21	17	17	4.6
Iron	.23	.28	.20	.24
Manganese	.00	.00	.00	.00

Scotland Neck, Halifax County -(continued)

	Well 1	Well 2	Well 3	Well 4
Calcium	5.2	4.6	2.8	3.2
Magnesium	1.0	1.2	.9	1.6
Na + K	13	14	9.6	7.3
Bicarbonate	11	12	6	3
Sulfate	9.5	5.2	6.3	.8
Chloride	15	17	9.1	8.2
Fluoride	.1	.1	.1	.1
Nitrate	6.6	9.0	8.6	19
Dissolved solids	81	79	61	50
Total hardness	17	16	11	15

Stoneville, Rockingham County

Population, 1940 - 615 (Population, 1950 - 786)

Source	Well	Magnesium	1.8
Depth (ft.)	185	Na + K	9.0
Diameter (in.)	8	Bicarbonate	54
Yield (g.p.m.)	75	Sulfate	1.0
Sample collected	9-23-49	Chloride	1.4
Treatment	none	Fluoride	.0
Color	2	Nitrate	.2
pH	6.3	Dissolved solids	92
Silica	43	Total hardness	28
Iron	.06		
Manganese	.00		
Calcium	8.2		

Walnut Cove, Stokes County

Population, 1940 - 1,084 (Population, 1950 - 1,132)

Source	Well		
Depth (ft.)	1,027	Calcium	30
Diameter (in.)	10	Magnesium	5.7
Yield (g.p.m.)	133	Na + K	8.1
Sample collected	12-13-48	Bicarbonate	116
Treatment	none	Sulphate	1.3
Color	2	Chloride	10
pH	7.2	Fluoride	.2
Silica	34	Nitrate	6.0
Iron	.16	Dissolved solids	159
Manganese	.00	Total hardness	98

Williamston, Martin County

Population, 1940 - 3,966 (Population, 1950 - 4,975)

Source	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7
Depth (ft.)	500	450	450	450	360	360	460
Diameter (in.)	8	6	6	6	8	8	8
Yield (g.p.m.)	400	85	85	85	130	130	450
Sample collected	10-15-47	same	same	same	same	same	3-14-49
Treatment	none	none	none	none	none	none	none
Color	13	7	7	7	7	5	5
pH	7.9	8.1	8.1	8.1	8.2	8.1	7.9
Silica	17	16	16	16	10	8.0	17

Williamston, Martin County - (continued)

	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7
Iron	.50	.16	.16	.16	.07	.06	.24
Manganese	.00	.00	.00	.00	.00	.00	.00
Calcium	1.8	.6	.6	.6	1.1	1.4	7.8
Magnesium	2.7	1.2	1.2	1.2	1.2	1.5	1.6
Na + K	326	232	232	232	153	148	185
Bicarbonate	368	374	374	374	389	382	346
Sulphate	63	34	34	34	4.8	4.6	25
Chloride	250.	116.	116.	116.	7.5	6.5	80.
Fluoride	1.5	1.8	1.8	1.8	2.0	1.7	1.7
Nitrate	1.2	1.0	1.0	1.0	1.2	.2	.7
Dissolved solids	872	606	606	606	386	376	496
Total hardness	16	6	6	6	8	10	26

Windsor, Bertie County

Population, 1940 - 1,747 (Population, 1950 - 1,781)

Source	Well 1	Well 2	Well 3
Depth (ft.)	334	325	350
Diameter (in.)	8	2	8
Yield (g.p.m.)	75	35	300
Sample collected	2-2-49	2-2-49	5-17-49
Treatment	none	none	none
Color	7	4	2
pH	7.9	7.8	7.0
Silica	19	16	26
Iron	.16	.16	.89
Manganese	.00	.00	.09
Calcium	4.5	2.4	17
Magnesium	2.9	1.2	4.0
Na + K	244	269	95
Bicarbonate	426	416	216
Sulfate	60	66	24
Chloride	95	127	42
Fluoride	2.9	2.7	1.3
Nitrate	1.1	.9	.1
Dissolved solids	648	704	3.6
Total hardness	23	11	59

Yanceyville, Caswell County (unincorporated)

Population, 1940 - 600 (Population, 1950 - 1,391)

Source	Well 3	Well 4
Depth (ft.)	100	175
Diameter (in.)	6	6
Yield (g.p.m.)	12	28
Sample collected	10-20-48	10-20-48
Treatment	none	none
Color	2	2
pH	7.0	6.5
Silica	46	36
Iron	1.0	.13
Manganese	.00	.00

Calcium	22	8.6
Magnesium	6.2	3.6
Na + K	13	7.6
Bicarbonate	90	58
Sulfate	4.2	1.5
Chloride	20	2.1
Fluoride	.2	.2
Nitrate	3.1	.3
Dissolved solids	167	88
Total hardness	80	36

Other Data pertaining to Public Water Supplies - Bulletins number 51 and 55, published by the North Carolina Department of Conservation and Development and prepared in cooperation with the Geological Survey, U. S. Department of the Interior, contain information regarding public water supplies in the Roanoke River Basin as follows:

Draper, Rockingham County

Draper, an unincorporated town with a 1950 population of 3,629, is supplied with water from Smith River at Spray, by Marshall Field and Company. The plant is described hereinafter under the Town of Spray. There are about 340 service taps in Draper, and the average consumption is about 25,000 gallons a day.

Danbury, Stokes County

Danbury, the county seat, is an unincorporated town of about 300 people. The water supply is owned by W. G. Petree, and the water is obtained from three springs northwest of the town. The water is pumped into two concrete reservoirs with a combined capacity of about 25,000 gallons. Distribution from the reservoirs is entirely by gravity. The water is not treated.

Halifax, Halifax County

Halifax (1940 population - 374, 1950 population - 356) has had a municipal water supply since 1940, being supplied from three gravel-walled wells, 59-61, inclusive, in the Table of Wells on page 42, Bulletin No. 51. Two of the wells are about 50 feet deep and yield water from sand strata in the Yorktown formation of miocene age. The third well is about 110 feet deep and yields water from sand in Cretaceous strata. The wells arepumped with deep-well turbine pumps and discharge into the aeration and filter tank. Well 62, owned by M. W. Perry, is connected to the system to augment the city supply in times of emergency. Well 59, with a yield slightly higher than the combined yields of wells 60 and 61, is not used much because of excessive iron in the water. A 75,000-gallon elevated tank serves as storage and to maintain a uniform pressure. An electrically-driven booster pump forces the water into the mains from the filter tank. Pressure varies between about 49 to 65 pounds per square inch. The average consumption is about 17,000 gallons a day. Treatment consists of aeration and filtration.

Jackson, Northampton County

Jackson, county seat, with a 1940 population of 758 and a 1950 population of 843, gets its water from six shallow wells at the north edge of the town (No. 69 in table on page 63, Bulletin No. 51). The system was constructed in 1937. These wells are about 40 feet deep and are spaced about 25 feet apart. There is a two-horsepower electrically-driven vacuum pump for each two wells, three pumps in all, pumping directly into the mains. When ground-water levels are high, the combined yield is 60 to 70 gallons per minute, but the yield decreases to 30 or 40 gallons per minute during periods of drought. A 75,000 gallon elevated tank is the only storage. Water pressure in the distribution system varies between 40 and 50 pounds per square inch. The only treatment consists of the addition of sodium hydroxide by a small pump directly into the system. The average consumption of water is about 25,000 gallons per day.

Kernersville, Forsyth County

Kernersville (1940 population - 2,103, 1950 population - 2,396) first obtained its water supply from wells. The well supply was abandoned in 1927 because of failure of the wells to supply sufficient water. The town now obtains its water from a small creek about one mile west of Kernersville. (It is understood that this creek is a tributary of Salem Creek, one of the headwaters of the Yadkin River. Parts of Kernersville lie in the Roanoke, Yadkin, and Cape Fear River Basins. Information, as to which of the abandoned wells in Kernersville, three municipally owned and one privately owned, is or are located in the Roanoke River Basin, is not available). A dam, 10 feet high, impounds about 7,500,000 gallons of water in a lake covering 8 acres. The water is pumped to the filter plant at the west edge of the town by two electrically driven centrifugal pumps with a total capacity of 900 gallons a minute. Treatment consists of the addition of lime and alum, settling, chlorination, filtration, post-chlorination, and addition of Calgon. The water flows from the filter plant to a 300,000-gallon, round, concrete clear-water reservoir. It is pumped into the mains by two electrically-driven centrifugal pumps with a total capacity of 1,300 gallons a minute. An elevated tank near the center of the town serves as additional storage and to equalize the pressure. The capacity of the filter tank is 1,000,000 gallons a day. There are 477 service taps and 64 hydrants. The maximum consumption is about 250,000 gallons a day, and the average consumption is about 200,000 gallons a day.

Leaksville, Rockingham County

Leaksville (1940 population - 1,886, 1950 population - 4,045), obtains its water from the Dan River at a point about 2 miles southwest of the center of the town. The water is pumped to the raw-water reservoir at the treatment plant by two centrifugal pumps with a capacity of 750 gallons a minute each. The raw-water reservoir has a capacity of 1,000,000 gallons. The water flows through the treatment plant by gravity. Treatment consists of coagulation with alum and sodium hydroxide, settling, filtration, and chlorination. The clear-water reservoir has a capacity of about 500,000 gallons. Two centrifugal pumps with a capacity of 750 gallons a minute each are used to distribute the water. A 150,000-gallon elevated tank furnishes additional storage. The capacity of the filter plant is about 1,000,000 gallons a day. There are 1,185 service taps, and consumption averages about 400,000 gallons a day, about 20 percent being used by industries.

Littleton, Halifax and Warren Counties

Littleton (1940 population - 1,200, 1950 population - 1,173) has had a municipal supply since 1921. The water is obtained from well 2 (page 41, Bulletin No. 51), which is a drilled well, 358.5 feet deep. It yields 120 gallons a minute and is pumped by a deep-well turbine pump, which discharges directly into the mains. A 60,000 gallon elevated tank is interconnected with the mains. A 100,000-gallon, round, concrete reservoir furnishes additional storage, water being pumped from it by a gasoline motor-driven pump in case of an emergency such as a fire. Consumption averages about 100,000 gallons a day, of which 20 percent is industrial. The water is not treated.

Madison, Rockingham County

Madison (1940 population - 1,683, 1950 population - 1,789) obtained its water supply from wells 159, 160, 161, and 162 (page 98, Bulletin No. 55) until 1937. The yield became inadequate at that time, and the town has since purchased treated water from the Washington Mill Company at Mayodan. The water

is delivered into a 200,000-gallon underground concrete reservoir in Madison. Two electrically-driven centrifugal pumps, with a capacity of 500 gallons a minute each, are used to distribute the water. A 100,000-gallon elevated tank furnishes additional storage. There are about 350 service taps, and average consumption is about 55,000 gallons per day, 10 percent of which is used by industries.

Mayodan, Rockingham County

Mayodan (1940 population - 2,323, 1950 population - 2,246) is supplied with water from Mayo River by the Washington Mills Company. The intake is at the dam about half a mile north of the town. Centrifugal pumps are used to pump the water to the treatment plant. Treatment consists of prechlorination, coagulation with alum and sodium carbonate, settling, filtration, and post-chlorination. The capacity of the plant is 600,000 gallons a day, and average consumption is about 450,000 gallons a day, of which about 70 percent is used by the mills, 12 percent is sold to the Town of Madison, and the remainder, about 80,000 gallons a day, is used by the inhabitants of Mayodan.

Milton, Caswell County

Milton (1940 population - 329, 1950 population - 317) has had a public water supply since 1940. The water is obtained from a well, 312 feet deep, drilled in gneiss and schist. The well, number 39 in table (page 65, Bulletin No. 55), has a tested yield of 75 gallons a minute. The water is pumped by a deep-well piston pump discharging directly into the mains. An elevated tank, with a capacity of 28,000 gallons, is connected with the system and serves as storage. There are about 50 service taps, and the average consumption is about 10,000 gallons a day. The water is not treated. An analysis of a sample from the well is given in the table of analyses (page 68, Bulletin No. 55). The water is quite hard, but the iron content is moderately low and probably causes little if any trouble. The temperature of the water was 60.5 degrees F. on June 4, 1943.

Reidsville, Rockingham County

Reidsville (1940 population - 10,387, 1950 population - 11,708) has had a public water supply since about 1900. The city obtains its water from Troublesome Creek about 5.5 miles southwest of the city. Three centrifugal pumps, with a combined capacity of 2,100 gallons a minute, pump the water from the intake, above a wooden diversion dam, to the treatment plant in the city. Treatment consists of coagulation, settling, filtration, and chlorination. The plant capacity is about 1,500,000 gallons a day. There are about 2,500 service taps. Maximum consumption is about 1,000,000 gallons a day, and the average is about 500,000 gallons a day, of which about 40 percent is used by industries. The clear-water reservoir has a capacity of 900,000 gallons, a standpipe has a capacity of 976,000 gallons, and two elevated tanks have capacities of 75,000 and 500,000 gallons, respectively.

Rich Square, Northampton County

Rich Square (1940 population - 942, 1950 population - 971) has had a municipal water supply since 1938. Its water is obtained from two drilled wells (Nos. 98 and 99, page 64, Bulletin No. 51), yielding 140 and 120 gallons a minute, respectively. Well 98 is used almost entirely as the water contains much less iron than well 99 which is used as an auxiliary supply. Analyses of the water from these two wells is given in the table of analyses (page 64, Bulletin No. 51). The wells are pumped by electrically-driven deep-well turbine

pumps delivering directly into the mains. A 100,000-gallon elevated tank, the top of which is 130 feet above the ground, serves as a reservoir and to equalize the pressure on the system. The maximum pressure is about 533 pounds per square inch, with much less pressure out on the ends of the lines. Average consumption is about 50,000 gallons a day. The water is not treated.

Roanoke Rapids, Halifax County

Roanoke Rapids (1940 population - 8,545, 1950 population - 8,156) has had a municipal supply since 1933. The system is owned by the Simmons Company and is operated by the Roanoke Rapids Sanitary District, organized under the provisions of Sections 130-133 to 130-165, inclusive, General Statutes of North Carolina, as amended. The source of supply is the Roanoke River, the water usually being pumped from a canal by two centrifugal pumps, but water can be taken directly from the river in case of emergency. Two centrifugal pumps, with a total capacity of 2,000 gallons a minute, force the water into the mains from the 1,250,000 gallon, concrete, clear-water reservoir. A 500,000-gallon elevated tank, in the center of the town, serves to distribute the load and maintain the pressure. Filter capacity is about 2,250,000 gallons a day. Maximum consumption is about 2,000,000, and averages about 1,300,000, gallons a day, of which about 70 percent is used by industries. The water is treated by addition of alum, soda ash, activated carbon, and anhydrous ammonia, and is filtered and chlorinated.

Rural Hall, Forsyth County

Rural Hall, an unincorporated town with a population of about 425, has had a public water supply since 1940. The water supply, which is owned and operated by the Rural Hall Sanitary District (organized under the provisions of Section 130-33 to 130-57.1, inclusive, General Statutes of North Carolina, as amended) is obtained from a well 350 feet deep (number 3 in the table on page 71, Bulletin No. 55). The well was tested at 125 gallons a minute and is pumped by a turbine pump at 35 gallons a minute. The well is on a sharp bill and is drilled in gneiss. The water is pumped directly into the mains without treatment. A 75,000-gallon, elevated tank is used for storage and to equalize the water pressure. Maximum pressure is about 70 pounds, and the minimum is about 48 pounds per square inch. There are 135 service taps. Consumption averages about 35,000 gallons a day.

Scotland Neck, Halifax County

Scotland Neck (1940 population - 2,559, 1950 population - 2,730) has had a municipal water supply since 1916. From 1916 to 1937, the water came from springs and wells. The supply from the springs was inadequate during dry seasons, and several wells were drilled to augment the supply. These wells were drilled between 30 and 40 feet deep and yielded about 10 gallons a minute each, and one was drilled to 200 feet, yielding about 20 gallons a minute. In 1937, three gravel-walled wells, 132 to 134, inclusive, in the table (page 44, Bulletin No. 51), were drilled. These wells, from 60 to 96 feet deep, obtain their water from sand strata in the Yorktown formation and Cretaceous deposits. They yield from 75 to 200 gallons a minute each and have entirely replaced the former supplies. The water is pumped by an electrically-driven turbine pump at each well which discharges a fine spray into a 15 x 10 x 8 foot concrete reservoir at each well. Booster pumps are used to force the water into the mains. Storage is obtained in a 200,000-gallon, round concrete tank and a 75,000-gallon elevated tank. Average consumption is about 125,000 gallons a day. Aeration at the wells is the only treatment.

Data regarding Agricultural Production - Information regarding farm population, total land in farms, harvested croplands, idle cropland, and use of fertilizer, according to the 1952 Farm Census of 1951 crops, for the counties within or partially within the Roanoke River Basin, is shown below. Approximate figures for the portions of these counties that lie within the Basin may be obtained by using the following percentages: Bertie - 72.6, Caswell - 89.4, Forsyth - 28.5, Granville - 32.6, Halifax - 40.9, Martin - 74.2, Northampton - 34.3, Person - 62.3, Rockingham - 83.7, Stokes - 84.5, Vance - 52.1, Warren - 38.9, and Washington - 13.4. The figures shown in the tables below are in acres, unless otherwise indicated.

ITEM	Bertie County	Caswell County	Forsyth County	Granville County	Halifax County	Martin County	Northampton County
Harvested Cropland	85,512	54,464	56,282	68,553	140,280	74,176	111,253
Idle Cropland	3,754	26,734	27,252	13,566	12,816	1,607	6,269
Pasture	6,130	26,516	23,281	23,714	24,598	6,671	9,871
Woods, Home-Sites,etc.	193,006	164,753	102,075	183,724	229,475	127,849	176,042
Corn Harvested	32,400	15,883	13,731	24,627	40,627	29,831	31,531
Cotton Harvested	9,455	- -	210	556	32,991	3,933	27,626
Tobacco Harvested	8,743	14,114	7,351	18,830	9,507	13,100	661
Peanuts	29,830	- -	- -	- -	38,424	20,246	39,616
Wheat	13	6,029	7,176	1,823	1,785	100	552
Oats	247	1,429	7,726	735	2,103	286	1,045
Other Small Grains	23	393	2,146	387	417	55	434
Soybeans	5,666	76	369	178	6,160	4,637	6,688
Lespedeza	13	456	1,399	247	1,437	35	247
Hay Crops Harvested	643	12,921	15,175	14,448	3,640	330	2,378
Other Hays Cut	83	1,338	2,062	2,670	1,287	56	739
Irish Potatoes	279	322	278	381	495	297	399
Sweet Potatoes	549	270	202	355	754	849	504
Other Vegetables Grown	585	124	1,212	300	757	373	361
Other Crops Harvested	635	2,008	2,055	2,187	2,829	1,073	1,385
Total Land in Farms	288,402	265,467	208,890	289,557	407,169	210,303	303,435
Total Land Area	443,520	278,400	271,360	347,520	462,080	307,840	345,600
Comm. Fert. Used, Tons	18,704	12,602	11,050	18,491	29,533	23,109	19,539
Sows and Gilts, No.	5,311	958	593	594	4,338	4,554	4,972
Cows and Heifers, No.	2,606	4,639	5,979	6,266	5,686	2,152	3,172
Hens and Pullets, No.	70,801	65,811	91,307	69,416	79,765	72,441	100,251
Tractors in Usable condition, No.	1,276	904	1,141	786	1,109	857	1,112
Farm Population, No.	13,098	15,941	17,915	18,011	25,337	14,070	18,110
Total Population, 1950, No.	26,439	20,870	146,135	31,793	58,377	27,938	28,432

ITEM	Person County	Rockingham County	Stokes County	Vance County	Warren County	Washington County	Total for Basin Counties
Harvested Cropland	57,158	70,930	54,552	42,484	59,967	29,799	905,510
Idle Cropland	13,037	26,713	27,673	6,782	11,925	3,360	181,488
Pasture	16,313	31,674	22,513	10,513	17,411	3,146	222,700
Woods,Home-Sites,etc.	155,074	201,201	162,143	80,391	153,492	38,441	1,967,566
Corn Harvested	18,141	19,074	16,533	12,169	15,299	9,400	279,234
Cotton Harvested	- -	- -	- -	4,369	12,172	815	92,127
Tobacco Harvested	14,558	19,556	16,729	12,206	9,496	1,378	146,229
Peanuts	- -	9	- -	- -	539	4,386	134,563
Wheat	4,528	7,948	2,948	1,502	4,809	127	39,329
Oats	1,520	3,253	2,355	748	2,007	289	23,743
Other Small Grains	349	1,847	298	489	613	155	7,606
Soybeans	44	106	21	545	1,163	11,703	37,356
Lespedeza	201	495	33	94	291	179	5,127
Hay Crops Harvested	11,425	13,469	10,508	7,967	11,222	968	105,094
Other Hays Cut	530	2,341	1,813	878	1,924	31	15,752
Irish Potatoes	406	317	444	233	287	32	4,170
Sweet Potatoes	190	288	308	228	307	72	4,876
Other Vegetables Grown	124	576	40	299	1,117	210	6,078
Other Crops Harvested	1,720	3,689	3,338	1,838	1,396	382	23,535
Total Land in Farms	241,582	330,518	266,881	140,419	242,795	74,746	3,270,164
Total Land Area	256,000	366,080	293,760	172,160	283,500	215,040	4,042,860
Comm. Fert. Used, Tons	13,178	18,909	14,624	12,864	13,838	5,208	211,649
Sows and Gilts, No.	580	426	218	488	1,030	1,187	25,249
Cows and Heifers, No.	4,484	6,692	4,799	2,791	5,421	894	55,581
Hens and Pullets, No.	59,450	99,781	112,333	50,721	49,796	21,910	943,783
Tractors in Usable Condition, No.	929	1,442	1,067	417	490	368	11,898
Farm Population, No.	15,879	22,504	17,476	13,061	15,626	4,798	212,826
Total Population, 1950, No.	24,361	64,816	21,520	32,101	23,539	13,180	519,501

Permits to Use Water for Irrigation - - The following permits to use surface waters in the Roanoke River Basin for the purpose of irrigation have been issued by the Director of the Department of Conservation and Development in accordance with the provisions of Section 113-8.1, General Statutes of North Carolina, as amended:

Stokes County

Permit No.	Name	Address	Source	Amount (c.f.s.)
167	F. D. Young	R#1, Walnut Cove	Sandy Br., Town Cr.	0.25
431	O. W. Young	R#1, Walnut Cove	Br. of Mills Cr.	1.14
201	T. D. Preston	Pine Hall	Belews Cr.	1.19
200	T. D. Preston	Pine Hall	Eurins Cr.	1.19
202	W. J. Blackwell	Pine Hall	Eurins Cr.	1.00
748	Sam F. Young	Pine Hall	Br. of Eurins Cr.	0.76

Forsyth County

660	Clifton Hartman	R#2, Belews Cr.	Belews Cr.	0.68
201	T. D. Preston	Pine Hall	Belews Cr.	1.19
790	R. Eugene Love	R#2, Walnut Cove	Br. of Lick Cr.	0.39

Rockingham County

Permit No.	Name	Address	Source	Amount (c.f.s.)
162	J. C. Vaden	R#1, Mayodan	Br. of Mayo River	0.14
669	W. H. Everette	R#4, Reidsville	Br. of Massey Cr.	0.38
34	C. W. Meeks	R#4, Reidsville	Terries Cr.	0.36
92	E. W. French	R#1, Ruffin	Quaqua Cr.	0.43
100	V. C. Dickerson	R#2, Ruffin	Birch Fork Cr.	0.72
582	W. Y. Barker	R32, Ruffin	Br. of Wolf Island Cr.	0.45
231	G. W. East	R#2, Ruffin	Wolf Island Cr.	0.54
154	Percy Strader	R#2, Ruffin	Wolf Island Cr.	0.72
134	J. W. Chandler	R#1, Ruffin	Wolf Island Cr.	0.63
133	J. W. Chandler	R#1, Ruffin	Wolf Island Cr.	0.26
109	G. B. French	R#1, Ruffin	Wolf Island Cr.	0.47
132	J. W. Chandler	R#1, Ruffin	Lick Fork Cr.	0.26
156	E. R. Strader	Box 14, Ruffin	Br. of Hogans Cr.	0.35
98	J. G. Alston	234 Crescent Dr., Reidsville	Hogans Cr.	0.97
131	Mrs. C. R. Wharton	Ruffin	Wolf Island Cr.	0.29
762	William Patterson	P. O. Drawer 1109, Reidsville	Lick Fork Cr.	0.26

Caswell County

727	James Y. Blackwell	R#1, Ruffin	Br. of E. Prong Moon Cr.	1.44
741	Max T. Smith	Blanche	Br. of E. Fk. Rattle Snake Cr.	0.32
742	Allen M. Poteat	R#1, Yanceyville	Br. of County Line Cr.	0.64
743	Allen M. Poteat	R#1, Yanceyville	Br. of County Line Cr.	0.64
744	Allen M. Poteat	R#1, Yanceyville	Br. of County Line Cr.	0.64
331	Mrs. Alma Brandon	R#1, Blanche	Br. of County Line Cr.	0.84
396	C. Y. McKenney	Yanceyville	County Line Cr.	0.47
327	T. S. Smith	R#1, Yanceyville	East Prong Moon Cr.	0.41
317	W. A. Wood	Box 223, Yanceyville	Br. of Moon Cr.	0.32
311	H. T. Robertson	R#1, Providence	Br. of Moon Cr.	0.35
664	R. R. Shumaker	R#1, Blanche	Br. of S. Fk. Rattlesnake Cr.	0.65
232	R. G. Stracher	R#1, Pelham	Hogans Cr.	0.60
310	B. F. Daniels	R#1, Pelham	Br. of Hogans Cr.	0.56
309	C. J. Law	R#1, Pelham	Br. of Hogans Cr.	1.00
126	J. D. Jefferess	R#1, Pelham	Br. of Hogans Cr.	0.56
221	Mrs. M. P. Moore	Milton	Br. of Penson Cr.	0.48

Person County

690	J. M. Hamlet	R#1, Semora	Br. of South Hyco Cr.	0.22
689	I. J. Wolf	Hurdle Mills	Br. of South Hyco Cr.	0.65
269	Lindsay Wagstaff	R#1, Roxboro	Br. of Hyco River	1.90
271	Mrs. Emory Winstead Mrs. K. C. Wagstaff	R#1, Roxboro	Br. of Hyco River	1.14
270	Mrs.R.H. Satterfield	R#1, Roxboro	Br. of Duck Cr.	1.40
328	C. J. Ford	Box 515, Roxboro	Satterfield Cr.	0.32
170	S. W. Glenn	R#4, Roxboro	Br. of Storys Cr.	0.33
173	J. W. Rogers	R#2, Woodsdale	Maho Cr.	0.45
511	E. D. Talbert	Box 710, Roxboro	Cobbs Cr.	0.63

Washington County

252	J. L. Knowles	Plymouth	Conaby Cr. & Roanoke R.	1.51

Permit No.	Name	Address	Source	Amount
		Warren County		
721	F. F. Fleming	R#1, Manson	Br. of Ellingtons Cr.	0.49
686	W. B. Ellington	R#1, Manson	Ellingtons Cr.	0.52
676	A. S. Bugg	R#3, Warrenton	Roanoke River	3.21
		Bertie County		
554	D. C. Bryant	R#3, Windsor	Br. of Cuckelmaer Cr.	0.54
555	Gilbert Rhodes	Windsor	Br. of Roquist Cr.	0.41
553	J. W. Waters, Jr.	Windsor	Roquist Cr.	0.54
		Martin County		
142	Clyde Revels	R#2, Williamston	Sweetwater Cr.	1.34
639	L. J. Hardison	R#1, Williamston	Sweetwater Cr.	1.21
707	J. L. Knowles	Plymouth	Welch Cr.	1.51
733	Henry B. Winslow	312 W. Main St., Williamston	Roanoke R.	0.53
		Vance County		
695	M. A. Norwood	Townsville	Br. of Roanoke R.	0.32
696	J. J. Parham	R#5, Oxford	Br. of Michaels Cr.	0.48
697	Mayland Parham	R#5, Oxford	Br. of Michaels Cr.	0.48
703	Oliver Brewer	R#5, Henderson	Br. of Roanoke R.	0.79
715	R. B. Taylor	Townsville	Br. of Little Island Cr.	1.39
704	J. H. Brewer, Jr.	R#5, Henderson	Br. of Roanoke R.	0.79
705	Dr. Thomas Hunter	Henderson	Little Nutbush Cr.	0.48

Agricultural Use in Various Sections of the Basin

Dan River and Tributaries in North Carolina - The entire watershed is located in the Piedmont region of the State. The topography is characterized by rather high even-surfaced upland that has been dissected by valleys of numerous streams. The relief, brought about by the dissection of the Plateau country by drainage ways, includes narrow to fairly wide interstream ridges that range from undulating and gently rolling to rolling, with hilly, steep, and broken land on slopes leading to streams. The most distinctive feature of the landscape is Sauratown Mountain, located in the west central part of Stokes County. The agricultural activities of the area include the growing of field crops and animal husbandry, including dairying, beef cattle, and poultry. Tobacco is the principal source of income.

The Lower Roanoke River and its Tributaries in North Carolina - The watershed of the Lower Roanoke River drains parts of two physiographic regions of the State. The portion that is upstream from the vicinity of Gaston drains a part of the Piedmont region whereas that portion below the "fall line" in the vicinity of Gaston drains a part of the Coastal Plain. The relief of the Piedmont plateau region is generally decidedly rolling or hilly whereas, in the Coastal Plain region, the land is prevailingly flat or very gently rolling, the more rolling areas occurring along stream courses. The agricultural activities in the area include the growing of field crops, livestock, and poultry. Tobacco is the principal source of farm income.

Records of wells used to supply water to industries - The bulletins indicated below, prepared in cooperation with the Geological Survey, U. S. Department of the Interior, and published by the North Carolina Department of Conservation and Development, contain information regarding wells, in the Roanoke River Basin, used for the purpose of supplying water to industries, as follows:

No. 47, "Progress Report on Ground Water in North Carolina by M. J. Mundorff", 1945.
No. 51, "Ground Water in the Halifax Area, North Carolina, by M. J. Mundorff", 1946.
No. 55, "Ground Water in the Greensboro area, North Carolina, by M. J. Mundorff", 1948

Caswell County

Blanche
Stead Planing Mill
Depth: 84 feet, diameter: 6 inches, yield: 1 g.p.m., chief aquifer: gneiss, location: slope, supply not adequate.

Leasburg, 4 miles southwest of
U. S. Defense Plant Corporation (Plantation Pipe Line Co.)
Depth: 485 feet, diameter: 8 inches, yield: 55 g.p.m., chief aquifer: greenstone, location: draw, hardness: 402 parts per million, temperature: 61°F.

Yanceyville, 1.5 miles northwest of
Sunderland - Edmunds Lumber Company
Depth: 132 feet, diameter: 6 inches, yield: 7 g.p.m., chief aquifer: gneiss, location: slope, temperature: 61°F.

Halifax County

Littleton
Orange Crush Bottling Plant
Depth: 67 feet, diameter: 6 inches, chief aquifer: gneiss, yield: 12 g.p.m., cased 60 feet.

Roanoke Rapids
O. S. Thompson Ice Plant
Depth: 65 feet, diameter: 6 inches, chief aquifer: sunderland (?) gravel, yield: 24 g.p.m., reported to yield 24 g.p.m. with less than 30-foot drawdown.
Colonial Ice Company
Depth: 140-190 feet, diameter: 6-8 inches, chief aquifer: schist, yield: 10 g.p.m. Five wells in group are 8 inches; four, 6 inches. Four in use; 10 g.p.m. from all four.
Halifax Paper Company
Depth: 478 feet, diameter: 8 inches, chief aquifer: rock?, yield: 150 g.p.m., cased 40 feet, 240-foot drawdown reported.
Mitchell Lumber Company
Depth: 80 feet, diameter: 6 inches, yield: 40 g.p.m., cased 74 feet.
Mitchell Lumber Company
Depth: 35 feet, diameter: 4 inches, chief aquifer: Sunderland, gravel, coarse, yield: 27 g.p.m.

Roanoke Rapids (continued)

Johnson Laundry

Depth: 65 feet, diameter: 4 inches, location flat, chief aquifer: schist, yield: 100 g.p.m., water from quartz vein.

Weldon

Grant Brick Works

Depth: 30 feet, diameter: 5 inches, chief aquifer: Sunderland, sand, yield: 1-2 g.p.m.

Mandeville Mills

Depth: 77 feet, diameter: 4 inches, cased to bottom, supplies about ten families.

Halifax

Halifax Milling Company

Depth: 61 feet, diameter: 6 inches, chief aquifer: schist, yield: 7-8 g.p.m., cased 41 feet.

Scotland Neck

R. P. Blackfoot Ice Plant

Depth: 25 feet, diameter: 2 inches, chief aquifer: Sunderland, sand, yield: 5-10 g.p.m., four wells together yield 25 to 30 g.p.m.

Northampton County

Rich Square

Rich Square Coal & Ice Company

Depth: 28 feet, diameter: 1.25 inches, chief aquifer: Wicomico, sand, yield: 25-30 g.p.m., two wells yield 55 g.p.m.

Rockingham County

Stoneville

Stoneville Furniture Company

Depth: 216 feet, diameter: 8 inches, yield: 40 g.p.m., chief aquifer: shale (Triassic).

Spray

Marshall-Field & Co., General Office

Depth: 113 feet, diameter: 5,625 inches, yield: 2 g.p.m. ?, chief aquifer: Triassic, location: slope.

Marshall-Field & Co., American Warehouse

Depth: 152 feet, diameter: 5.625 inches, yield: 3 g.p.m. ? chief aquifer: Triassic, location: valley.

Marshall-Field & Co.

Depth: 35 to 150 feet, diameter: 6 inches, chief aquifer: shale (Triassic). About 100 wells, from 35 to 150 feet deep, in mill village. Adequate yield from all wells. Wells at woolen mill and suiting mill have been abandoned, and wells at bedspread mill and karastan mill are not used.

Spray Cotton Mills

Depth: 100 feet, diameter: 8 inches, yield: 15 g.p.m., chief aquifer: shale (Triassic), location: valley, temperature: 65.5°F.

Leaksville Woolen Mill

Depth: 80 feet, diameter: 6 inches, yield: 8 g.p.m., chief aquifer: shale (Triassic), location: valley.

Morehead Mills Company

Depth: 205 feet, diameter: 6 inches, chief aquifer: shale (Triassic), temperature: 61.5°F.

Draper

Marshall-Field & Co.

Depth: 150 feet, diameter: 6 inches, yield: 50 g.p.m., chief aquifer: shale (Triassic), location: valley. Two other wells, about 300 feet deep, yield about 30 g.p.m.

R. P. Roy Esso Station

Depth: 186 feet, diameter: 6 inches, yield: 10-12 g.p.m., chief aquifer: shale, location: slope.

Ben Eggleston Pure Oil Station

Depth: 145 feet, diameter: ?, yield: 7-8 g.p.m., chief aquifer: shale.

Oregon Hill

Pure Oil Station

Depth: 170 feet, diameter: 6 inches, yield: 4 g.p.m., chief aquifer: gneiss, location: slope, soft water.

Reidsville

Edna Mills Corporation

Depth: 160 feet, diameter: 6 inches, yield: 30 g.p.m., chief aquifer: gneiss, location: valley.

Mayodan

Washington Mills Company

Depth: 300 feet, diameter: 6 inches, yield: 15-20 g.p.m., chief aquifer: shale (Triassic), hard water, not in use (1948). Four other wells have been abandoned.

Stokes County

Sandy Ridge, 3.5 miles northwest of

Banner Mills

Depth: 63 feet, depth: 6 inches, yield: 5 g.p.m., chief aquifer: schist. Large yield. Water contains iron.

Pine Hall, 0.5 mile west of

Pine Hall Brick & Pipe Co.

Depth: 75 feet, diameter: 5 inches, yield: 5 g.p.m., chief aquifer: shale (Triassic), location: valley.

Pine Hall, 1 mile west of

Pine Hall Brick & Pipe Co.

Depth: 65 feet, diameter: 4 inches, yield: 5 g.p.m., chief aquifer: shale (Triassic), location: ridge. Seven other wells, 45 to 65 feet deep, yield 3 to 5 g.p.m. each.

Pine Hall, 1.75 miles southwest of

Depth: 60 feet, diameter: 4 inches, yield: 5 g.p.m., chief aquifer: shale (Triassic), location: hill. Five other wells, 45 to 60 feet deep, yield 0.25 to 5 g.p.m. each. Some of them go dry during periods of drought.

Pine Hall, 2.25 miles southwest of

Depth: 95 feet, diameter: 4 inches, yield: 10 g.p.m., chief aquifer: conglomerate (Triassic), location: valley.

Depth: 45 feet, diameter: 4 inches, yield: 10-15 g.p.m., chief aquifer: sand (Aluminum), location: valley, soft water.

Spray, Rockingham County

Spray, an unincorporated town with a 1950 population of 5,542, is partially supplied with water by Marshall Field and Company from Smith River. Two centrifugal pumps, with a capacity of 2,800 gallons a minute each,, are used at the intake. Treatment consists of pre-chlorination, addition of ammonia, coagulation with lime and alum, settling in an 850,000-gallon basin, filtration, and post-chlorination. The clear well has a capacity of 150,000 gallons. The water is distributed by five centrifugal pumps with a total capacity of 6,000 gallons a minute. The capacity of the plant is 4,000,000 gallons a day. Maximum consumption is about 3,500,000 gallons a day, and the average is about 2,500,000 gallons a day. About 98 percent is used by the mills in Spray and Draper, and 2 percent is used by the inhabitants of Spray and Draper. Some of the inhabitants of Spray and Draper use wells, of which there are reported to be about 100 in Spray alone (see table on pages 95 and 96, Bulletin No. 55).

Walnut Cove, Stokes County

Walnut Cove (1940 population - 1,084, 1950 population - 1,132) has had a public water supply since about 1926. The water is obtained from well 113 (page 107, Bulletin No. 55), which is 1,027 feet deep and 10 inches in diameter. The well is drilled in Triassic rocks and driven by a 15-horsepower electric motor. The pump discharges directly into the mains. A 100,000-gallon elevated tank, located on a hill at the north edge of the town, furnishes storage. Maximum pressure is about 82 pounds, and the minimum is about 42 pounds per square inch. There are about 175 service taps. Maximum consumption is about 40,000 gallons a day, and the average is about 30,000 gallons a day. The water is not treated.

Weldon, Halifax County

Weldon (1940 population - 2,341, 1950 population - 2,295) has had a municipal supply since 1908. The town now obtains water from the Roanoke River at Roanoke Rapids through a 12-inch supply line. The water is taken from the same canal that supplies the City of Roanoke Rapids. The head is sufficient to deliver 1,200 gallons a minute at Weldon by gravity, but booster pumps are available at the intake for increasing the delivery to 1,800 gallons a minute. There is a 500,000 gallon, earthen, raw-water reservoir at the filter plant, and the treated water is pumped into the mains by a 750-gallons-a-minute centrifugal pump. A 75,000-gallon elevated tank serves as storage and to equalize the load and pressure. Treatment consists of the addition of alum, soda ash, ammonia, and copper sulfate, and of chlorination and filtration. The capacity of the plant is 1,250,000 gallons a day. Maximum consumption is about 200,000 gallons a day, of which about 12 percent is used by industry.

Wentworth, Rockingham County

Wentworth, a small unincorporated town of a few hundred people, is the county seat. About 150 people, and the courthouse and other county buildings, are supplied with water from a drilled well. The well, number 142 in the table (page 98, Bulletin No. 55), is 588 feet deep, 6 inches in diameter, and yields 30 gallons a minute. The well is drilled in gneiss. It is pumped by a plunger pump at a rate of about 20 gallons a minute. A 5,000-gallon, elevated tank serves for storage. Consumption averages about 10,000 gallons a day. The water is not treated. An analysis of the water is given in the table of analyses (page 100, Bulletin No. 55).

Yanceyville, Caswell County

Yanceyville, the county seat, is an unincorporated town with an estimated 1940 population of about 500 to 600 and a 1950 population of 1,391, and has been supplied by the Yanceyville Sanitary District (organized under the provisions of Section 130-133 to 130-57.1, inclusive, General Statutes of North Carolins, as amended) since 1937. The water is obtained chiefly from a drilled well, number 87 in the table (page 66, Bulletin No. 55). Prior to 1943, the water was obtained from wells 79, 81, and 82 (see page 66, Bulletin No. 55). In 1943, the pipe line to the C.C.C. Camp was extended to well 87, which is now the main source of supply. This well is 183 feet deep and was tested at 75 gallons a minute for 25 hours, with a drawdown of 150 feet. The water is pumped directly into the system. An 80,000-gallon, elevated tank, a short distance from the center of the town, serves as storage and to equalize the pressure, which ranges from 45 to 50 pounds per square inch. There are about 140 service taps, and about 30,000 gallons of water are used each day. Except for chlorination of water from some of the wells, the water is not treated. Analyses of water samples from wells 79 and 82 are given in the table of analyses (page 68, Bulletin No. 55).

Other Public Water Supplies - - The following information is taken from "Roanoke River Basin Pollution Survey Report, State Stream Sanitation Committee, North Carolina State Board of Health, 1956".

Norlina, Warren County

Population (1950)	869
Estimated population served	700
Estimated consumption, g.p.d.	40,000
Number of wells	- -
Date installed	1948
Treatment	none

Plymouth, Washington County

Population (1950)	4,800
Estimated population served	4,000
Estimated consumption, g.p.d.	120,000
Number of wells	2
Date installed	1914
Treatment	none

Stoneville, Rockingham County

Population (1950)	786
Estimated population	825
Estimated consumption, g.p.d.	40,000
Number of wells	2
Date installed	1938-50
Treatment	none

Williamston, Martin County

Population (1950)	4,978
Estimated population served	4,200
Estimated consumption, g.p.d.	350,000
Number of wells	- -
Date installed	1919
Treatment	none

Windsor, Bertie County

Population (1950)	1,800
Estimated population served	1,600
Estimated consumption, g.p.d.	200,000
Number of wells	2
Date installed	1920
Treatment	none

Roxboro, Person County

Population (1950)	5,500
Estimated population served	15,000
Estimated consumption, m.g.p.d.	1.0
Source of supply	Storys Creek
Impounded	yes
Date installed	1924
Design capacity, m.g.p.d.	3.0
Treatment: Coagulation, sedimentation filtration, chlorination	

Hanging Rock State Park - This park is in Stokes County, four miles northwest of Danbury, 14 miles from Walnut Cove, and 32 miles north of Winston-Salem. It is accessible over paved roads from North Carolina Highways 89 and 66.

Located in the Sauratown Mountains, one of the most easterly mountainous areas in the State, Hanging Rock State Park offers a variety of features, both natural and man-made, that afford interest and pleasure. Here is natural beauty in profusion. Rugged mountain terrain; clear, sparkling mountain streams, waterfalls, and cascades; a cool, inviting lake nestled in the hills; extensive growths of laurel, rhodendron, stewartia, and other flowering shrubs; beautiful interior and distant views - all these await the visitor.

Included in the 3,865 acres of Hanging Rock State Park are Hanging Rock and Moore's Knob. From Moore's Knob, elevation 2,572 feet, one may look across the valley of the Dan River, with its patchwork of tobacco fields, to the Blue Ridge Mountains of North Carolina and Virginia. From Hanging Rock, miles of the upper portion of the Piedmont Plateau are spread out before the eye.

Hanging Rock State Park lies on the Piedmont Plateau, an ancient erosion-surface underlain by highly altered rocks. Most of the rocks were originally sandstone, but under conditions of great heat and pressure, they were changed to massive quartzites and foliated rocks such as quartz-schist and quartz-mica schist. Hanging Rock, Cook's Wall, and Moore's Knob owe their greater height to the fact that they are composed of quartzite - a type of rock with superior resistance to erosion. Under the combined action of heat and cold and water, the softer rocks have been eroded, leaving the quartzite to form peaks. Also interesting geologically is a rare and peculiar type of sandstone, itacolumite, which is flexible and may be easily bent.

The wealth of plant life at Hanging Rock State Park is particularly interesting, not only to the botanist but, because of the beauty of flower and form of many of the species, to the layman as well. Plants typical of the Piedmont and of the lower mountain ranges are represented. Although the work of identification is not complete, over three hundred different species have been listed, some of them being quite uncommon.

Paved park roads provide access to all developed public-use facilities. Parking areas serve picnic areas, bathhouse, and lake. Swimming is available in the lake which has a sand beach and a protected water area. The park is open from June 1 through Labor Day. Boats for use on the lake may be rented at the boathouse. Bass and panfish may be caught in the lake. There are two picnic areas, each equipped with picnic shelter, tables, benches, outdoor fireplaces, water, and toilets. Cold drinks, sandwiches, candies, cigarettes, souvenirs, etc., may be purchased at the picnic areas and the bathhouse. The park has a tent and trailer campground with individual camp sites and central washhouse and toilets. There are six completely-equipped vacation cabins. The park has nature trails for nature study, with a naturalist on duty during the summer months, and a system of foot trails to points of interest. A stone lookout-tower is located on Moore's Knob.

Fishing - This form of recreation is available in the various counties of the basin, and in the streams of the upper and lower sections of the basin, as follows:

Bertie - Fishing for bass, bream, crappie, and pike in the large rivers and numerous creeks is excellent.

Caswell - Bass and perch in Roanoke River and tributaries.

Granville - Bass and perch in ponds. Several species of fish in the Little Island Creek arm of John H. Kerr Reservoir.

Halifax - Shad, rockfish, white perch, bass, carp, and garfish in Roanoke River. The spring spawning run of rockfish (striped bass) at Weldon is phenomenal and attracts fishermen and netters from all over the country.

Martin - Large-mouth bass, perch, pike, and rockfish in Roanoke River, Sweetwater Creek, and Conoho Creek.

Northampton - Large-mouth and small-mouth bass in Jordan's Mill Pond. The national champion small-mouth bass was taken from this pond in 1940. Striped bass and perch in Roanoke River.

Person - Fishing is available in Hyco River and several creeks. Bass in Lake Chub about four miles northwest of Roxboro.

Stokes - Trout and perch in headwaters of Roanoke River and numerous creeks.

Warren - Fishing is available in several creeks in the northern part of the county and in that portion of John H. Kerr Reservoir which occupies the northwestern corner of the county.

Washington - Fishing is available in Conaby Creek, Welch Creek, Roanoke River, and Albemarle Sound.

Dan River and Tributaries - Fishing is prevalent in most of the larger streams in the area. The environmental conditions of the upper reaches of the Dan River are suitable for trout, and part of the Dan River has been designated as trout waters by the North Carolina Wildlife Resources Commission. Bass, bream and crappie are common to these waters. Several streams of the area have been stocked with bass and bream.

Lower Roanoke River and Tributaries - Fishing is prevalent in most of the larger streams of the area. Bass, bream, crappie, and other species of pan fish are common to the waters of the area. The Lower Roanoke River is a very important spawning ground for striped bass or "rockfish". The North Carolina Wildlife Resources Commission operates the only known striped-bass hatchery in the world at Weldon. The striped bass fishing has been valued at more than one million dollars annually. The John H. Kerr Reservoir and its backwaters in North Carolina comprise a very popular sport-fishing area.

Recreational potential - The scenic nature of the Sauratown Mountain section as well as the relatively clean water, afford an excellent environment for recreation. The attractions and facilities of Hanging Rock State Park have been previously indicated in this chapter.

The Boy Scouts maintain and operate Camp Cherokee near Wentworth in Rockingham County. The Camp has a spring-fed lake that is used for swimming and boating.

The Episcopal Church owns and operates Camp Vade Mecum in Forsyth County north of Winston-Salem, for both boys and girls. The Camp has a swimming pool that is supplied with water from a nearby stream.

Camp Civitan, Camp Lassiter, and Camp Betty Hastings are located on Redbank Creek in Forsyth County. Campers use the stream for recreational purposes including swimming.

The recreational potential of the drainage area of the Dan River is more fully developed than the area of the Lower Roanoke River and its tributaries. There are no State parks or camps in this section. That portion of the John H. Kerr Reservoir in Granville, Vance, and Warren Counties offers great opportunities for recreation. There are several developed landings along the lake, operated by Wildlife Clubs and private citizens. The lake affords opportunities for fishing, boating, water skiing, and swimming.

Electric Power - Electric-power demands are supplied by the transmission lines of the Carolina Power and Light Company, the Virginia Electric and Power Company, and the Duke Power Company. Some of the industries in the area operate generators that supply all or a part of their requirements for electricity. The United States Government, through its operation of the John H. Kerr Dam, sells electricity to the private power companies that supply the area. The power plants in the basin, together with the rated capacity and type of each installation, are shown in the following table:

Name	Rated Capacity	Type	Owner
Walnut Cove	680 KVA	Hydro	Duke Power Company
Dan River	180,000 KVA	Steam	Duke Power Company
Roanoke Rapids	91,000 KW	Hydro	Virginia Electric & Power Company

Plans have been submitted to the Federal Power Commission for the construction of hydroelectric projects that will utilize practically all of the hydroelectric-power potential of the Roanoke River in North Carolina. Of the existing and proposed projects, the John H. Kerr project, built and operated by the Corps of Engineers, U. S. Army, for flood control and power generation, is the largest. Virginia Electric and Power Company has applied to the Federal Power Commission for a license to construct another dam to be known as the Gaston Project. The backwaters of the Roanoke Rapids Dam extend to the site of the proposed Gaston Dam which would create a pool extending upstream to the toe of the John H. Kerr Dam.

Even though a hydroelectric project adds no pollutants to the water, it may, from the standpoint of altering water quality, be equivalent to a source of pollution. In large lakes or reservoirs, the water near the bottom is considerably colder than the water near the surface and may be completely devoid of oxygen. If the turbine intakes draw water from near the bottom, the water discharged through the turbines may contain little or no dissolved oxygen.

Stream Flow Records - Mean monthly, maximum daily, minimum daily, and mean weekly discharges, all in million gallons per day, at eight gaging stations in the Roanoke River Basin, may be found in "Hydrologic Data on the Roanoke and Tar River Basins, 1871-1945", published in 1952 by the North Carolina Department of Conservation and Development and prepared in cooperation with the United States Geological Survey. Stream-flow data for years subsequent to 1945, at six of these gaging stations, are shown below. Operation of gaging stations, Dan River at Leaksville and Ronoke River at Old Gaston, have been discontinued.

Dan River near Francisco, Stokes County

Location - Water-stage recorder, lat. 36°30' 15", long. 80°20' 55", at bridge on State Highway 704, just downstream from Georges Mill, 3 miles east of Francisco, Stokes County, and 7.9 miles downstream from Little Dan River.

Drainage Area - 124 square miles

Records available - August 1824 to date

Average discharge - 22 years (1924-1945), 121 m.g.d.

Extremes (1924-1945) - Maximum discharge, 8,010 m.g.d. Oct. 19, 1937 (gage height, 12.45 feet); minimum discharge, 4.59 m.g.d. (regulated) Sept. 8, 1932 (gage height, 0.43 foot); minimum daily, 19 m.g.d. Sept. 18, 20, 1932.

Remarks - Records good except those for periods of ice effect, which are poor. Considerable diurnal fluctuation and some regulation caused by Pinnacles power plant, 28 miles upstream, and two reservoirs with a total capacity of 416 million cubic feet.

	1946	1947	1948	1949	1950	1951	1952	1953
Minimum monthly discharge (m.g.d.)	41	42	31	65	58	34	54	31
Mean monthly discharge (m.g.d.)	147	127	128	171	122	110	131	105
Maximum monthly discharge (m.g.d.)	711	2380	891	937	590	885	956	1380
Minimum mean weekly discharge (m.g.d.)	70	79	57	85	71	49	74	36
Maximum mean weekly discharge (c.f.s.)	607	869	534	712	478	477	694	785
Minimum mean weekly discharge (c.f.s.)	108	123	89	131	110	76	115	56

Mayo River near Price, Rockingham County

Location - Water-stage recorder, lat. 36° 32' 00", long. 75° 59' 30", just downstream from Anglins Bridge, half a mile downstream from confluence of North and South Mayo Rivers, three-quarters of a mile downstream from Virginia-North Carolina State line and 4 miles west of Price, Rockingham County.

Drainage area - 260 square miles

Records available - July 1929 to date

	1946	1947	1948	1949	1950	1951	1952	1953
Maximum mean weekly discharge (m.g.d.)	1510	2130	1630	1540	1780	1010	1240	672
Minimum mean weekly discharge (m.g.d.)	138	109	180	311	187	116	122	99
Maximum mean weekly discharge (c.f.s.)	2330	3300	2520	2390	2760	1560	1920	1040
Minimum mean weekly discharge (c.f.s.)	214	169	278	482	289	180	189	154
Maximum daily discharge (m.g.d.)	4520	8850	6090	3960	5960	3600	2870	2580
Maximum daily discharge (c.f.s.)	6990	13700	9420	6130	9230	5570	4450	3990
Minimum daily discharge (m.g.d.)	112	96	140	292	167	93	98	65
Minimum daily discharge (c.f.s.)	174	148	217	452	258	144	152	101

Dan River near Wentworth, Rockingham County

Location - Water-stage recorder, lat. 36° 24' 45", long. 79° 49' 45", at Settles Bridge, 3½ miles northwest of Wentworth, Rockingham County, and 7½ miles downstream from Mayo River.

Drainage area - 1,050 square miles

Records available - November 1939 to date.

Extremes (1939-1945) - Maximum discharge, 36,700 m.g.d. Sept. 18, 1945 (gage height, 27.78 feet), from rating curve extended above 10,700 m.g.d. on basis of slope-area determination at gage height 26.9 feet and runoff comparisons; minimum discharge, 96 m.g.d. (regulated) Sept. 11, 1944 (gage height, 1.32 feet); minimum daily 118 m.g.d. Sept. 11, 1944.

Remarks - Records good. Slight diurnal fluctuation at low stage caused by power plants above station.

	1946	1947	1948	1949	1950	1951	1952	1953
Maximum monthly discharge (m.g.d.)	7300	12400	7750	8470	4580	6650	7560	8790
Mean monthly discharge (m.g.d.)	731	804	896	1065	707	625	741	637
Mean monthly discharge (c.f.s.)	1132	1245	1387	1649	1095	967	1147	986
Minimum monthly discharge (m.g.d.)	239	236	252	451	272	165	248	129
Maximum mean weekly discharge (m.g.d.)	2670	3320	2680	3050	1820	2290	3460	2900
Minimum mean weekly discharge (m.g.d.)	282	262	287	517	360	181	193	141
Maximum mean weekly discharge (c.f.s.)	4130	5140	4150	4720	2820	3550	5360	4490
Minimum mean weekly discharge (c.f.s.)	437	406	445	801	557	280	444	219
Maximum daily discharge (c.f.s.)	11300	19200	12000	13100	7090	10300	11700	13600
Minimum daily discharge (c.f.s.)	370	366	391	698	421	255	384	200

Roanoke River at Roanoke Rapids, Halifax County

Location - Water-stage recorder, lat. 36°28'15", long. 77°38'05", 1½ miles downstream from State highway 47 at Roanoke Rapids, Halifax County. Datum of gage is 43.79 feet above mean sea level, datum of 1929, supplementary adjustment of 1936. Auxiliary water-stage recorder at bridge on U. S. Highway 301, 3.4 miles downstream. Datum of auxiliary gage is 16.06 feet above mean sea level datum of 1929, supplementary adjustment of 1936.

Drainage area - 8,410 square miles.

Records available - February 1930 to date. December 1911 to December 1932 at site 9 miles upstream, published as Roanoke River at Old Gaston (Hydrologic Data on the Roanoke and Tar River Basins, 1871-1945, North Carolina Department of Conservation and Development, 1952).

Average discharge - 16 years (1930-1945), 5,662 m.g.d.

Extremes - 1930-1945: Maximum discharge, 169,000 m.g.d. Aug. 18, 1940 (gage height, 39.0 feet, from floodmarks); minimum discharge, 296 m.g.d. (regulated) Sept. 21, 1932 (gage height, 1.25 feet; minimum daily, 305 m.g.d. (regulated) Sept. 21, 1932.

Remarks - Records excellent above 3,230 m.g.d. and good below. Diurnal fluctuation at low flow caused by power plant above station. Discharge during floods computed, using submergence by auxiliary gage as a factor.

	1946	1947	1948	1949	1950	1951	1952	1953
Maximum monthly discharge (m.g.d.)	3210	33800	4520	3380	25800	24000	23200	18500
Mean monthly discharge (m.g.d.)	5163	5171	6893	6925	4953	4397	4107	3786
Mean monthly discharge (c.f.s.)	7993	8005	10670	10720	7667	6806	7906	5861
Minimum monthly discharge (m.g.d.)	1270	1220	1440	2450	1810	956	445	595
Maximum mean weekly discharge (m.g.d.)	18500	17200	26900	19100	11400	15900	18000	10900
Minimum mean weekly discharge (m.g.d.)	1460	1420	1590	2560	2000	1090	613	1270
Maximum mean weekly discharge (c.f.s.)	28700	26600	41700	29500	17700	24600	27900	23310
Minimum mean weekly discharge (c.f.s.)	2260	2220	2460	3970	3090	1690	949	1970
Macimum daily discharge (c.f.s.)	49700	52300	7000	52300	4000	37200	35400	28600
Minimum daily discharge (c.f.s.)	1960	1890	2240	3800	2800	1480	689	921

Roanoke River near Scotland Neck, Halifax County

Location - Water-stage recorder, lat. 36°12'30", long. 77°23'10", at U. S. Highway 258, 1 mile downstream from tributary on right (Halifax County), 3 miles downstream from Bridgers Creek (Northampton County), and 5 3/4 miles north of Scotland Neck. Auxiliary water-stage recorder at Atlantic Coast Line Railroad Bridge, 8¼ miles downstream. Datum of each gage is 5.77 feet above mean sea level, datum of 1929, supplementary adjustment of 1936.

Average discharge - 17 years (1929-1945), 205 m.g.d.

Extremes (1929-1945) - Maximum discharge, 19,400 m.g.d. Oct. 19, 1937 (gage height, 14,000 feet), from rating curve extended above 5,200 m.g.d.; minimum discharge, 26 m.g.d. (regulated) Sept. 19, 1932 (gage height, 0.52 foot); minimum daily, 28 m.g.d. (regulated) Sept. 19, 1932.

Remarks - Records good except those for periods of ice effect or no gage-height record, which are poor. Some diurnal fluctuation at low flow caused by mills above station.

	1946	1947	1948	1949	1950	1951	1952	1953
Mean monthly discharge (m.g.d.)	224	206	227	300	208	183	205	174
Mean monthly discharge (c.f.s.)	347	319	351	464	320	284	318	269
Maximum mean weekly discharge (c.f.s.)	1060	2320	982	1250	932	811	1197	1140
Minimum mean weekly discharge (c.f.s.)	147	119	140	245	181	105	126	79
Maximum mean weekly discharge (m.g.d.)	685	1500	634	659	602	524	773	736
Minimum mean weekly discharge (m.g.d.)	95	83	90	158	117	68	81	51
Maximum daily discharge (c.f.s.)	2790	8410	8020	3070	2030	4360	3200	4760
Minimum daily discharge (c.f.s.)	139	112	133	237	153	98	119	70
Maximum daily discharge (m.g.d.)	1800	5430	1950	1980	1310	2820	2070	3070
Minimum daily discharge (m.g.d.)	90	72	86	153	99	63	77	45

Smith River at Spray, Rockingham County

Location - Water-stage recorder, lat. 36° 31' 47", long. 79° 46' 08", 0.9 mile south of Virginia-North Carolina State line, 1 mile downstream from Stuart Creek, and 1 mile north of Spray, Rockingham County. Datum of gage is 539.56 feet above mean sea level, datum of 1929, supplementary adjustment of 1936.

Drainage area - 538 square miles

Records available - October 1939 to date

Extremes (1939-1945) - Maximum discharge, 29,500 m.g.d. Aug. 15, 1940 (gage-height, 19.28 feet), by computation of flow over dam; minimum discharge, 41 million gallons per day (regulated) Jan. 12, 1942 (gage height, 1.38 feet); minimum daily, 43 m.g.d. (regulated) Sept. 10, 1954.

Remarks - Records good except those for periods of ice effect, which are poor. Diurnal fluctuation and some regulation caused by power plant above station.

	1946	1947	1948	1949	1950	1951	1952	1953
Mean monthly discharge (m.g.d.)	397	378	460	613	435	371	362	242
Mean monthly discharge (c.f.s.)	615	585	712	949	674	574	561	375

Drainage area - 8,700 square miles.

Records available - August 1940 to date

Extremes - 1940-1945; maximum discharge, 168,000 m.g.d. Aug. 19, 1940; maximum gage height, 41.98 feet Aug. 19, 1940; minimum discharge, 775 m.g.d. Oct. 16, 1941.

Remarks - Records good. Discharge computed by using fall as determined by auxiliary gage as a factor.

	1946	1947	1948	1949	1950	1951	1952	1953
Mean monthly discharge (m.g.d.)	5532	5325	7093	7235	5109	4455	5380	3994
Mean monthly discharge (c.f.s.)	8563	8243	10980	11200	7909	6896	8328	6182
Maximum mean weekly discharge (m.g.d.)	18200	16000	22300	17000	11700	15800	17600	15100
Minimum mean weekly discharge (m.g.d.)	1650	1510	1640	2640	2050	1027	704	1340
Maximum mean weekly discharge (c.f.s.)	28100	24700	43000	26300	18100	24400	27200	23300
Minimum mean weekly discharge (c.f.s.)	2550	2340	2540	4390	3180	1590	1090	2080
Maximum daily discharge (m.g.d.)	24400	23700	39300	24700	17000	20200	19400	16700
Maximum daily discharge (c.f.s.)	37700	36700	60800	38300	26300	31200	30000	25800

Lakes, Ponds, and Reservoirs - Examinations of North Carolina State Highway and Public Works Commission maps indicate that the following lakes, ponds, and reservoirs are located in the Roanoke River Basin in North Carolina:

County	Name	Stream on which located
Bertie	Hardens Pond	Wading Place Creek
Bertie	Burdens Mill Pond	Cashie River
Granville	John H. Kerr Reservoir	Grassy, Jonathan, and Spewmarrow Creeks
Martin	Statons Pond	Sweetwater Creek
Northampton	Barrows Mill Pond	Gumberry Swamp
Northampton	Boones Mill Pond	Gumberry Swamp
Person	Lake Chub	Storys Creek
Person	Water Works Lake	Satterfield and Storys Creeks
Vance	Island Creek Reservoir	Island and Little Island Creeks
Vance	John H. Kerr Reservoir	Anderson Swamp, Crooked Run, and Flat, Indian, and Nutbush Creeks

Caswell, Forsyth, Rockingham, and Stokes Counties - Information regarding these four counties, large parts of which lie in the Roanoke River Basin, and Alamance and Guilford Counties, most of which lie in the Cape Fear River Basin, may be found in "Bulletin No. 55, Geology and Ground Water in the Greensboro Area, North Carolina", by M. J. Mundorff, published in 1948 by the North Carolina Department of Conservation and Development in cooperation with the Geological Survey, United States Department of the Interior. The following material is extracted from Bulletin No. 55.

Source - The source of the ground water in the Greensboro area, comprising the six counties indicated above, for all practical purposes is from precipitation as rain or snow. Little or no water is derived from the interior of the earth in the area.

The average yearly precipitation in the area is nearly 45 inches. In eastern United States, stream flow carries off about one-third of the precipitation as direct run-off. It is estimated (Meinzer, O. E., Hydrology, p. 401, McGraw Hill, 1942) that about one-third of the precipitation reaches the water table. The remaining third is lost by evaporation and transpiration before reaching the water table.

In the Greensboro area, where the surficial materials in many places are impermeable clays, the recharge may be somewhat less than average. Thus, recharge to the ground water in this area is probably somewhat less than 15 inches per year. Although seasonal fluctuations of the water table are considerable and there may be a considerable change in water level between dry and wet years, over a period of many years the net change in water level is zero, assuming no long-term climatic change, so that the average recharge to the ground water is equaled by the average annual discharge. Ground water is discharged through springs, seeps, and wells, and by evaporation and transpiration. Most of the water, discharged by the springs and seeps, enters the streams and maintains their flow during periods of no rainfall.

Occurrence - - Large quantities of water are contained below the surface in the openings or interstices in the rocks. These interstices range in size from the minute pores in clays to large tunnels and caverns in lavas and limestones. The interstices in unconsolidated sedimentary rocks, such as gravel, sand, and clay, are the pores or openings between the sand or clay particles. Crystalline rocks such as granite, gneiss, and schist have little space between the component grains. The interstices in these rocks are the joints, fractures, cleavage planes, planes of schistosity, bedding planes, and solution channels. Consolidated rocks, such as the Triassic sandstones and shales, have their primary porosity reduced by compaction and by the deposition of minerals between the grains. However, in these rocks, jointing and fracturing has produced secondary interstices in which water may accumulate . . . .

The porosity of a rock is the percentage of the total volume that is occupied by the interstices. . . . A saturated rock or soil may have a large porosity and yet yield little water even though allowed to drain for a long time. A clay, with a porosity of 50 percent, might not yield any water by gravity because of the smallness of the pores, the water being retained because of molecular attraction. Some water may also be retained in a rock because the interstices are isolated or poorly interconnected. Even in clean, coarse, well-sorted sand, an appreciable part of the water will be retained as a thin film on the surface of the grains, and thicker films will be retained at the intersection of the surfaces of the grains. The ratio of the volume of water a saturated rock will yield by gravity, to the total volume of rock, is known as the specific yield and is stated as a percentage.

Probably the most important characteristic of an aquifer is its permeability, that is, its relative ability to transmit water. This characteristic may have little relation to the porosity; a clay, with a porosity of 50 percent may transmit water very slowly, or not at all, whereas a sand or gravel with a porosity half as great may transmit large quantities of water in a short time. Clays are impermeable because the pores are so small that the water is held by molecular attraction. In silt and extremely fine sand, the pores are larger and the molecular attraction is less but may still be so great that water is transmitted very slowly. A small amount of clay or fine sand will greatly decrease the permeability of a medium or coarse sand. The concepts of porosity, specific yield, and permeability apply particularly to more or less homogeneous materials such as soil, clay, sand, gravel, semi-consolidated sandstones, and some limestones. It is more difficult to apply these concepts to rocks in which the interstices consist entirely of fractures, joints, cleavage planes, and similar openings, because the rocks are non-homogeneous.

The movement of ground water is usually due entirely to the force of gravity, and ordinarily the velocity of flow varies directly with the hydraulic gradient. Under natural conditions, the points of discharge are at a lower elevation than the points or areas of recharge.

In a humid region, such as the Greensboro area, recharge to the ground water is in the interstream areas. The ground water discharges into the perennial streams and lakes, and the lowest points on the water table are at these places. Rain water percolates more or less vertially downward to the water table and then moves laterally toward the point of discharge in some stream valley, lake, or swamp. The streams contribute to ground-water recharge only in periods of flood, when they recharge the alluvium and bedrock along their channels. This water generally drains quickly back into the streams when the floods pass.

During the winter and spring, when the water table is high, the head is great. Therefore, the velocity is higher and the volume of discharge is greater than in the autumn when the water table is low.

The Water Table - Rain falling on an area percolates downward through the soil until it reaches the zone of saturation, beneath which all of the pores and interstices are completely filled with water. The surface of this zone of saturation is known as the water table. The water table is not a stationary surface but is continually fluctuating, rising during and immediately following periods of rainfall and declining during periods of fair weather. In humid regions such as the Greensboro area, the water table is an undulating surface, usually reflecting, in a subdued way, the irregularities of the topography. The relief - that is, the difference in elevation between high and low points - of the water table generally is much less than the relief of the topography.

The depth to the water table depends principally upon the climate, the topography, and the character of the rocks. As the climate is nearly uniform throughout the Greensboro area, and most of the rocks are consolidated, brittle rocks, with similar types of interstices, differences in depth to the water table depend largely upon the topography. In stream valleys, the water table may be at or very near the surface. On wide, flat uplands, the water table generally ranges from a few feet to a few tens of feet below the surface. On hills and in sharply dissected areas near the larger streams, the water table may be more than 100 feet below the surface. The greatest depth to water measured in the Greensboro area was 161 feet in a well in Stokes County on a high hill rising above the valley of Dan River. . . . .

Fluctuations of the Water Table - Because the source of ground water is precipitation, the water table fluctuates with the rainfall. However, a number of factors complicate the correlation of ground-water level and rainfall. The intensity and duration of the rainfall has a considerable bearing upon the proportion of water that runs off directly, evaporates, and reaches the water table. A heavy rainfall of short duration may result in a high percentage of surface runoff because of the inability of the soil to transmit the water to the water table rapidly. The same amount of rain, falling over a longer period, may result in a much larger proportion of water reaching the water table. However, during the longer period of rainfall, there might be an increase in the total amount of water evaporated, thus reducing to that extent the amount of water that will reach the water table.

Temperature also has a considerable effect. The viscosity of water varies inversely with temperature, so that cold water percolates through the earth more slowly than warm water. This means that water, recharged during cold weather, moves downward to the water table more slowly than water recharged when the weather is warm. When the ground is frozen, no water can percolate downward to the water table.

The evaporation capacity of the air, which is dependent upon temperature, humidity, and the rate of air movement, determines the rate of evaporation and thus has considerable bearing on the proportion of rainfall that may reach the water table. Transpiration losses through vegetation may have even a greater effect.

During the summer, evaporation and transpiration losses are high, and much of the rainfall occurs in short, heavy showers that result in high surface run-off. It is principally because of these three reasons that the ground-water level recedes during the summer and autumn although these months have the heaviest rainfall.

During the winter, the vegetation is dormant, so that little water is lost by transpiration, the evaporative capacity of the air is low and little water is lost by evaporation, and rain is apt to fall slowly and steadily. Therefore, the ground-water supplies are replenished during these months although the rainfall is less during these months than in the summer and autumn. However, the first winter rains often do not have as much effect on the water level as the late winter and spring rains because of the general deficiency in soil moisture by late autumn. Soil, consisting of varying proportions of fine sand, silt, and clay, will hold a considerable amount of water by the molecular attraction of the particles, and this water does not percolate downward to the water table. After a long period, this water, called the soil moisture, is depleted by evaporation and transpiration, perhaps for many feet below the surface. Before any water can reach the water table, this soil-moisture deficiency must be made up. This sometimes requires several weeks or months of winter rains, during which the ground-water level continues to decline.

The porosity and permeability of the soil differ from place to place and, therefore, affect the proportion of rainfall that produces ground-water recharge. The porosity and permeability of the soil may be changed by rainfall, heavy rains beating down and compacting the soil. The type of vegetation and land usage will have considerable effect on the porosity and permeability, and intensive cultivation usually reduces both . . . .

Records of Water-Level Fluctuations in the Greensboro Area - - The usual seasonal cycle of the water-level fluctuations in the Greensboro area begins with a marked rise in December or January, continuing until March or April, after which there is almost a continuous decline except when unusually heavy rainfall causes slight rises. The water level rises in winter, because in spite of low rainfall, a large part of the rainfall reaches the water table. Vegetation is dormant, so that transpiration losses are very low, and the low temperature results in small evaporation losses. In March or April, the vegetation begins to use large amounts of water and warmer weather causes a great increase in evaporation, so that the water level declines although rainfall is greater than during the winter. Transpiration and evaporation losses reach a maximum during the summer, so that the decline of the water level continues in spite of the much greater rainfall in June, July, and August. The losses by transpiration and evaporation are less in September, October, and November, but rainfall is also less, so that the decline of the water level continues. Furthermore, the soil moisture has usually been depleted by the excessive transpiration and evaporation. Continued heavy rainfall is necessary during the summer to raise the water level. . . .

Utilization of Ground Water - - Ground water in the Greensboro area is obtained from wells and springs. The different types of wells include dug, bored, and drilled wells.

Dug Wells - - More domestic water supplies in the Greensboro area are obtained from dug wells than from any other type. Dug wells in the area range from a few feet to nearly 100 feet in depth. The hole is generally dug between 30 and 60 inches in diameter. When the well is curbed with terra cotta or concrete pipe, the inside diameter usually is 24 to 30 inches. The inside diameter of masonry - or rock-curbed wells and uncurbed wells generally is somewhat greater. Dug wells have certain advantages over other types of wells but also have certain disadvantages. Probably the most important consideration that leads to the choice of a dug well is that of cost. Generally, this is the least expensive method of obtaining a water supply, with the possible exception of bored wells. Furthermore, many wells on farms and on the fringes of towns are dug by the owner in his spare time or in slack seasons, so that there is no cash outlay from digging. However, cost is not always in favor of the dug well, particularly where bedrock is encountered before a satisfactory supply is obtained. The cost of dug wells under such conditions has been reported at several places to have exceeded the cost of the average drilled well in the neighborhood. A second advantage of the dug well is the large storage capacity as compared particularly with the small-diameter drilled wells. A well 24 inches in diameter will contain nearly 24 gallons of water per foot of depth, as compared to 1 1/2 gallons and 1/6 gallon per foot of depth for wells 6 inches and 2 inches in diameter, respectively. Thus, even though the yield of a well may be very low, a fairly large quantity of water can be withdrawn in a short time.

Dug wells have two important disadvantages. Usually, the depth of water in a dug well is not great, either because of the difficulty involved in digging below the water table or because bedrock is encountered. In periods of drought, therefore, many dug wells go dry. A second disadvantage is that the water in these wells is much more susceptible to pollution or contamination by the entrance of impure surface water. A survey made in Pennsylvania in 1930 and 1931, during which 17,665 water supplies were examined for purity, showed that the supplies from 90 percent of the drilled wells were safe whereas less than 50 percent of the supplies from dug wells were safe (Lohman, Stanley W., Ground water in northeastern Pennsylvania; Pennsylvania Topog. and Geol. Survey Bull. W4, p. 40, 1937).

The danger of contamination of dug wells can be decreased by observing certain precautions. All dug wells should be covered tightly to prevent direct entrance of contaminating material, either solid or liquid. The well should be cased or curbed with tile or concrete pipe or similar material, and the joints should be cemented to a depth of at least a few feet below the water table, but in any event to a depth of at least 10 feet below the surface. The space between the walls and the curbing should be filled, above the water-bearing bed, with clay. The dug well should be located several hundred feet from any source of contamination and up the ground-water slope from any nearby source of contamination.

Bored Wells - During recent years, many wells have been bored in the Greensboro area. These wells are very similar to dug wells, but, instead of being dug by hand, the earth is removed by a large auger operated by a machine. Bored wells are quickly constructed and are relatively inexpensive. They nearly always are cased with a terra cotta or concrete pipe and are usually tightly covered. The average depth in the Greensboro area is probably not more than 30 or 40 feet, which is somewhat less than that of dug wells, as boulders of any considerable size are encountered. The usual diameter of bored wells is 18 to 24 inches. Bored wells as a group probably have a higher percentage of safety from pollution than dug wells as they are nearly always tightly cased and covered. Because wells can easily be bored for a considerable depth below the water table, this type of well is not apt to go dry during periods of drought. However, bored wells cannot be used where the water table is below the zone of completely decayed and disintegrated rock.

Drilled Wells - There are two methods of drilling wells in the area. The larger-diameter wells (6 to 10 inches) are usually drilled by the cable-tool (percussion) method, whereas nearly all wells 2 and 3 inches in diameter are sunk by core drilling with chilled shot.

In the cable-tool method, a portable rig is used that consists of a derrick, engine, drum, and cable, and the necessary drilling tools. After reaching the well site, the derrick is erected, and the cable is run from the drum over a sheave, at the top of the derrick, down to the string of tools, which consist of a short, heavy drill bit, a long drill stem for added weight and length, and a rope socket for attaching the cable to the drill stem. The well is drilled by abrasion of the rock by blows from the drill as it drops repeatedly after being raised a short distance by the machine. The drill is alternately raised and dropped about 25 or 30 times a minute. The well is always drilled with water in the hole, which holds the drill cuttings in suspension, so that the drill does not fall on previous cuttings but is always cutting fresh material. Periodically, usually after drilling a few feet, the drill is withdrawn and a bailer is used to remove the cuttings. The bailer consists of a long cylinder with a valve at the bottom which permits free entrance of the mud and water but closes as the bailer is lifted.

Shot-drilled wells are drilled by rotation of a cutting bit on the end of a string of pipe rotated by machine. The drill pipe is usually 3/4 inch or 1 inch in diameter, and the cutting bit is from 2 to 6 inches in diameter, depending on the size of well desired, and 6 or 8 feet long. The cutting bit has a slot cut in the end which helps it to grasp the shot that are poured into the top of the well. The chilled shot fall to the bottom of the well and are caught and held by the softer metal of the cutting bit. Rotation of the bit causes chipping and abrasion of the rock. Water is forced down the inside of the drill pipe and returns to the surface around the outside of the pipe, bringing with it the drill cuttings. Cores are removed from the drill bit when it is withdrawn from the hole.

Nearly every well drilled by either method is cased. Usually, the casing is driven down to solid rock, and attempt is made to seat it in the rock, so that shallow water can enter. Most cable-tool drilled wells in the Greensboro area, used for domestic supply, are 6 inches in diameter, although a few wells 4 or 5 inches have been drilled. Most industrial and municipal wells are 8 inches in diameter, but a few are 10. The majority of shot-drilled wells are 2 inches in diameter, but a considerable number of $2\frac{1}{2}$ and 3 inch wells, and a very few 4 - and 6 - inch wells, have also been drilled by this method.

For domestic purposes, a supply of a few hundred to a thousand gallons of water a day is usually sufficient for each family. Therefore, a yield of 1 or 2 gallons a minute is about the minimum that will be satisfactory. A 6-inch well will hold $1\frac{1}{2}$ gallons for each foot of well below the water table. Generally, the wells are drilled deep enough that the well contains 30 feet or more of water, both in an effort to obtain more water and also to increase the amount of water in storage. The smallest electrically-operated deep-well pump used generally has a capacity of about 3 or 4 gallons a minute, so that the storage will be exhausted in 15 or 20 minutes from a 6-inch well yielding 1 gallon a minute and having a storage of 30 feet of water. After the first 15 or 20 minutes, the yield will be only 1 gallon a minute. The amount of water that could be removed from such a well in an 8-hour day would be 510 gallons, and this would require practically continuous pumping.

The above illustration suggests that a yield of 1 gallon a minute is sufficient to supply 200 or 300 gallons a day satisfactorily but that a larger yield is required if 500 or 1,000 gallons a day is needed. In a 2-inch well, only 1/6 gallon per foot is held in storage, which is a negligible amount. Therefore, the amount of water that can be obtained at any time is approximately equal to the yield of the well. A well, yielding only a gallon a minute, will operate very inefficiently because most deep-well pumps are made to furnish at least 3 or 4 gallons a minute. Furthermore, it will require 50 minutes to obtain a 50-gallon barrel of water. For most domestic supplies from 2-inch wells, the minimum satisfactory yield is about 3 or 4 gallons a minute. For 6-inch wells, with their much larger storage capacity, a yield of $1\frac{1}{2}$ or 2 gallons a minute is about the minimum satisfactory yield.

Users of larger amounts of water can determine the yield needed by dividing the total daily water required by the number of minutes during which the well will be pumped each day. Thus, if 10,000 gallons is needed and the well will be pumped 8 hours (480 minutes) a day, then a well yielding 21 gallons a minute will be needed. In no case should a well be pumped at capacity more than about 12 hours a day because continuous pumping at capacity usually results in a gradually decreasing yield.

Factors to be considered in selecting a well site - - Everyone, who has had experience with wells in this area, knows that two wells a short distance apart may differ greatly in the amount of water yielded. One may be an excellent producer, whereas the other is a poor producer. Obviously, a great deal of care should be given to the selection of the most favorable location. In spite of this, most well sites are chosen for their convenience and are as close as possible to the place where the water will be used, with the thought that less pipe will be needed from the well to the place where the water is used. Also, servicing the pump takes less time. Selection of a well site for these reasons is generally very poor economy. Drilling a well in rock costs from about $3.00 a foot for a 2-inch well to about $8.00 a foot for an 8-inch well. From 20 to 50 feet of small pipe can be laid at the surface for the cost of one foot of drilling in rock. Taking a chance on a poor site, which may result in

40 to 40 feet of extra drilling in order to save a couple of hundred feet of pipe is poor economy. It is apparent that first consideration should be given to choosing the most favorable location for obtaining a satisfactory supply of water.

Although criteria for selecting well sites have not been thoroughly established, knowledge of certain geologic factors is very helpful . . . Coarse-textured rocks generally are better aquifers than fine-textured ones . . . Where cleavage planes and planes of schistosity are plentiful, and especially where movement along these planes has caused some degree of separation, the rock will yield more water. . . . Places where the rocks are closely folded are generally favorable for obtaining a satisfactory supply of water. Places where the beds are thin, so that the bedding planes are closely spaced, are also favorable . . . Wells drilled at places, where the rock is more closely jointed, sheared, or fractured, will usually yield more water than wells drilled into massive rocks. . . Many of the best wells in the Greensboro area obtain most of their water from quartz veins. . . In many places, wells drilled near dikes (rock bodies emplaced while the rock was still molten) have been proved to be better-than-average water producers. This is particularly true of the Triassic rocks.

All of the above factors - texture, cleavage, schistosity, bedding planes, joints, fractures, veins, and dikes - should be considered in selecting a well site. Where rock outcrops are plentiful, much can be learned from them. However, where the rock is covered by a thick layer of soil and disintegrated rock, the topography, which often reflects the character of the underlying rock, is an important indicator. Erosion is controlled largely by the relative resistance of the rock. Hills are left because the rock is more resistant to the erosive action of water, and depressions, such as valleys and draws, are cut at less resistive places. In many places, the rock in the draws and valleys is less resistant because of the presence of fractures, joints, and often openings, which facilitate the entrance of ground water and thus promote weathering. Therefore, wells drilled in draws and valleys should intersect more fractures and similar openings and thus yield more water. Also, the natural movement of ground water is toward the wells drilled in the depressions and away from the wells drilled on hills. The average well, drilled in a draw, is also somewhat better than the average well, drilled in a valley, and it seems probable that minor topographic features are more important than major ones. Thus, it may be wise to avoid a hill, only a few feet high, in selecting a well site; whereas, a depression, only a few feet deep and a few tens of feet wide, may be an excellent site.

Another factor to consider, in the choice of a well site, is the thickness of the soil and weathered material above solid rock. Because the extent of chemical weathering of a rock depends largely upon the access of water to the rock, a thick mantle of weathered material, overlying the bedrock from which it was derived, is an indication that the rock is jointed and fractured, or has interstices of some other type through which water can move. Furthermore, the thick layer of mantle, which is generally quite porous although the permeability may be low, serves as a reservoir to feed water into the fractures.

Most drilled wells are cased to hard rock. The depth of casing, therefore, generally is directly related to the thickness of the mantle. In the Greensboro area, 82 wells with 30 feet or less of casing had an average yield of 8.76 gallons a minute; 125 wells with 31 to 65 feet of casing had an average yield of 14.35 gallons a minute; and 100 wells with 66 or more feet of casing had an average yield of 20.52 gallons a minute.

Completion and Testing of Drilled Wells - Generally, the casing in a drilled well is driven tightly into the rock to seal out direct entrance of water from the mantle. This lessens danger of contamination and prevents entrance of turbid waters into the well, which sometimes occurs, particularly after a rainfall, in wells in which the casing is not tightly sealed in the rock. The space between the outside of the casing, and the soil at the surface, should be filled with cement or clay to prevent any surface water from running down along the outside of the casing. Surface drainage should be away from the well. The mouth of the well should be several inches above the surface and tightly closed.

The yield of only a small percentage of the wells drilled is accurately determined. The cost of adequately testing a drilled well is generally not more than about 5 percent of the cost of the well, and the information is nearly always worth many times the added cost. The length of test should be 2 hours or more on a well for domestic purposes, 24 hours or more on a well for a small industrial plant or public supply such as a school, and 48 hours or more on a well for a large industrial plant or a municipality. In making a pumping test, the static level of the well should be measured accurately before starting the pump, and the pumping level and yield should be measured at intervals for several different rates. After pumping ceases, the water level should be measured at intervals for several hours to determine the rate of recovery. With this information, the proper size of pump and pump setting can be determined, and an estimate of the pumping level at a future date can be made.

The majority of pumps used in the Greensboro area are deep-well pumps, although some shallow-well pumps are used. The terms "deep-well pump" and "shallow-well pump" are somewhat misleading because the depth of the well does not determine the type of pump required. A shallow-well (suction) pump will lift water satisfactorily not more than about 25 feet, and, if the pumping level (distance to water level below the pump while the well is being pumped) is less than 25 feet, a shallow-well pump will be satisfactory regardless of the depth of the well. If the pumping level is at a greater distance, a deep-well pump must be used. Many examples are known where dug wells, 40 or 50 feet deep, require deep-well pumps, whereas some drilled wells, several hundred feet deep, can be pumped with shallow-well pumps because their water levels are near the surface.

To obtain the most satisfactory service from a well, the owner or user should know certain essential facts about it. These include depth of well, diameter of casing and of the well below the casing, depth of casing, static water level, quantity of water yielded, and drawdown at the maximum yield. Knowledge of the depths, at which water was encountered in the well, is also very helpful. Data on the pump should include type of well and amount of suction pipe, if it is a shallow-well pump. The depth of setting of the cylinder, bowls, or jet should be known for a deep-well pump. With this information, decisions can be made regarding the possibility of increasing the yield by changing the pump installation. In order to determine the static water level and pumping level from time to time, the pump should be installed so that these measurements can be made. . . . .

Effect of Topographic Location - - There are several reasons why wells, drilled on hills, yield less water than wells, drilled in other locations. In homogeneous rocks, hills are apt to be formed because the underlying rock is more resistant to erosion than it is in the surrounding area. In some places, the greater resistance is due to a difference in rock which makes it harder, but, in most places, the rock has more resistance to erosion because it is less

jointed or fractured. Joints and fractures facilitate entrance of ground water which promotes chemical decay and permits mechanical erosion. Thus, depressions, such as draws and valleys, suggest that the rock, underlying the depressions, has more openings through which ground water can move than the rock, underlying the hills. Flat areas in the Greensboro area, usually, comprise land surfaces, worn down by erosion nearly to level land, and do not indicate anything about the resistance of the underlying rock. Theorectically, wells in flat areas should have about the same yield as the average for wells in all topographic locations. Actually the average yield is somewhat larger than the average for all topographic locations because, in flat areas, recharge to ground water is apt to be greater than elsewhere. However, the average for all locations is lowered by the large number of wells, drilled on hills, as compared to the number of wells, drilled in draws and valleys.

In non-homogeneous rocks, such as the bedded gneisses and schists and the Triassic sedimentary rocks, the topography, in many places, is often controlled by the relative ease of circulation of ground water, just as in homogeneous rocks. In the bedded rocks, however, circulation of water occurs along cleavage and bedding planes as well as along joints and fractures. Where bedding planes and cleavage planes dip steeply, most wells will end in the same kind of rock as that exposed within a few hundred feet of the well.

A second reason, that wells on hills yield less water than wells in valleys and draws, is that the direction of movement of the ground water is away from the wells drilled on the hills and toward the wells drilled in the valleys.

Wells drilled in draws have a 12 percent higher yield per foot of well than wells drilled in valleys. Draws include minor depressions which may or may not contain small streams. The distinction between a draw and a valley is more or less arbitrary and depends upon the interpretation of the observer. As used here, small, relatively narrow depressions, with angular or rounded sides and bottom, are considered to be draws. Valleys are much larger and, generally, have a flood plain or bottomland and have a perennial stream. It seems probable that the better record of wells in draws is because the draws more exactly mark the location of the structural weakness in the rocks. Valleys may have originated at their present location because of a zone of weakness, but this zone of weakness may be relatively small in comparison with the present size of the valley. Therefore, most of the wells drilled in the valleys quite possibly are not drilled into the zone of weakness that originally determined the course of the stream. On the other hand, a well drilled in a relatively narrow draw will have a very good chance of striking the zone of weakness. It would seem, then, that the minor topographic features are more important in choosing a well site than the larger features.

Relation of Depth of Well to Yield . . . Wells in the Greensboro area, less than 100 feet deep, have a greater average yield per foot of well below the water table than wells in any other depth range. . . . It is evident that the rocks below 250 feet are much poorer aquifers than those above that depth . . . The reason for the decrease in yield with increasing depth not only is that the number of fractures, joints, and other openings, through which the water moves, becomes much less in depth, but also the weight of the overlying rock causes the fractures and joints to be tighter and narrower.

Drilling to great depths is seldom sound policy in the rocks of the Greensboro area. If considerable quantities of water are not encountered above 250 or 300 feet, there usually is little chance of obtaining a large amount at greater depth. However, if the well yields 40 gallons a minute

at 250 feet and a yield of 50 gallons a minute is desired, the chances are good that the additional amount can be obtained by drilling 75 or 100 feet more.

Records of Wells - - Bulletin No. 55, North Carolina Department of Conservation and Development, contains description tables of well data giving information on 1,254 wells in the six counties in the Greensboro area. Plate 1 of the bulletin comprises a geologic map of the area, showing the locations of nine rock units and indicating the water-bearing properties of each of the units. Plate 2 shows the locations of the wells. Information regarding some of the wells in the Roanoke River Basin is set forth below.

Caswell County

Location	Owner	Depth of well (ft.)	Yield (g.p.m.)	Chief Aquifer	Topographic location
Pelham	Sam Pryor	100	1	Gneiss	Hill
Pelham	School	100	15	Schist	Draw
Pelham	H. M. Pryor	135	6	Schist	Valley
Providence	C. J. Fowkes	60	3.5	Gneiss	Draw
1 mi. s. of Providence	School	100	15	Schist	Slope
3 mi. NE of Providence	Dairy	140	3	Gneiss	Hill
Blanch	B. F. Allen	104	3.5	Gneiss	Hill
Blanch	Stead Planing Mill	84	1	Gneiss	Slope
1 mi. SW of Milton	D. O. Sunderland	129	15	Gneiss	Slope
1 mi. SE of Milton	J. F. McCain	114	7-8	Gneiss	Hill
3 mi. SE of Milton	G. W. Scott	155	1.5	Gneiss	Slope
1 mi. NW of Semora	Messrs Smith & Thomas	60	1-2	Gneiss	Low hill
Semora	Mrs. E. Y. McAden	100	16-18	Gneiss	Draw
1.5 mi. SW of Semora	W. W. Pointer	93	7-8	Granite	Flat
3 mi. NW of Leasburg	Robert Briggs	49	5	Granite	Slope
Leasburg	School	100	8	Greenstone	Flat
3.5 mi. W of Leasburg	W. P. Lunsford	66	2-3	Granite	Slope
Yanceyville	School	200	5	Gneiss	Flat
1 mi. N of Yanceyville	CCC Camp	183	75	Gneiss	Flat
2 mi. NW of Yanceyville	Dairy	109	15	Gneiss	Flat
Bethel	T.B. Low	112	4-5	Gneiss	Flat
1.5 mi.SW of Bethel	F. M. Low	160	1	Gneiss	Hill
2 mi. SW of Bethel	School	200	10	Gneiss	Low hill
3 mi. E. of Hightowers	E. W. Long	86	6	Granite	Slope
1½ mi. SE of Hightowers	D. S. Smith	45	0.75	Granite	Hill
2 mi. SE of Hightowers	W. M. Riggs	114	2-3	Granite	Slope

2.75 mi. N of Prospect Hill	W. L. Compton	140	10	Granite	Flat
1.25 mi. N of Prospect Hill	F. P. Riggs	42	20	Granite	Flat
2.5 mi. W of Prospect Hill	C. P. Murphy	70	1.5	Granite	Hill

The Caswell County wells in greenstone schist have the greatest average yield, but, because they also have the greatest average depth, the yield per foot of well is less than the yield per foot of well in both the gneiss and the sericite schist. Both the yield and yield per foot of wells in granite and in diorite are much less than in the other three units. . . Wells on hills have an average yield only 55 percent as large as wells at other locations and an average yield per foot of well only 65 percent as large. Wells drilled in draws have a considerable better average yield and average yield per foot of well than wells drilled at any other location . . . In general, the data obtained in Caswell County indicate that the best wells are drilled in gneisses and schists and the best locations are in draws. . . The importance of a thick mantle is indicated by the fact that 12 wells with 30 feet or less of casing had an average yield of only 3 gallons a minute, whereas 10 wells with 31 feet of casing or more had an average yield of 12.6 gallons a minute.

Rockingham County

Location	Owner	Depth of well (ft.)	Yield (g.p.m.)	Chief Aquifer	Topographic location
4 mi. W of Stoneville	Lee Webb	63	3-4	Gneiss	Slope
Stoneville	Town	101	20	Shale	Flat
3.5 mi. E of Stoneville	Emma Carter	80	4	Shale	Flat
3.5 mi. NW of Leaksville	Y. T. Joyce	120	10	Gneiss	Slope
3 mi. W of Leaksville	Sunset Dairy	122	2	Shale	Hill
3.25 mi. SW of Leaksville	Jim Wilson	80	7	Shale	Slope
2 mi. N of Spray	Pete Mabe	120	6-7	Conglomerate	Slope
1.5 mi. NE of Spray	Messers. Light and James	105	8-10	Conglomerate	Hill
Spray	Marshall-Field	195	9	Triassic	Valley
Leaksville	Marshall-Field	80	10	Shale	Valley
Draper	Marshall-Field	150	50	Shale	Valley
0.5 mi. W of Draper	J. M. Law	125	10	Shale	Slope
1.25 mi. S of Draper	S. G. Hopkins	80	10	Shale	Hill
3.5 mi. W of Oregon Hill	Tom Moore	90	15	Gneiss	Slope
3 mi. SW of Oregon Hill	F. L. Smith	175	0.25	Gneiss	Hill
1 mi. SW of Oregon Hill	E. M. Gunn	117	9	Gneiss	Flat
1.25 mi. SW of Ruffin	Chandler Estate	90	3-4	Gneiss	Flat

1 mi. SE of Ruffin	Mrs. Alice Chandler	100	10	Gneiss	Hill
2.25 mi. N of Ruffin	L. N. Dibrell	95	3	Gneiss	Slope
1 mi. S. of Lawsonville	J. L. Butler	60	1	Gneiss	Hill
3/4 mi. S. of Lawsonville	J. W. Butler	123	6-8	Gneiss	Hill
3 mi. N of Reidsville	G. T. Gordon	68	20	Gneiss	Slope
4 mi. E. of Reidsville	Roy Harris	40	2-3	Gneiss	Slope
2.75 mi. NW of Reidsville	R. R. Saunders	80	10	Gneiss	Slope
1.5 mi. SE of Wentworth	Prison Camp	44	25	Gneiss	Flat
Wentworth	County	588	30	Gneiss	Hill
3/4 mi. S of Wentworth	Mrs. Hugh Scott	110	3	Gneiss	Slope
1.5 mi. N of Intelligence	W. E. Puckett	78	8	Gneiss	Hill
1 mi. N of Intelligence	C. H. H. Martin	62	3-4	Gneiss	Slope
1 mi. W of Intelligence	V. G. Wilson	45	2	Gneiss	Flat
Madison	Town	300	75	Shale	Draw
1 mi. NW of Madison	Walter Bailey	75	2-3	Shale	Slope
1 mi. NW of Mayodan	H. R. Martin	99	3	Arkose	Hill
1.75 mi. W of Mayodan	H. G. Grogan	200	12	Triassic	Slope
2 mi. W. of Madison	Y. L. Carter	340	3	Triassic	Hill
2.75 mi.W of Madison	H. R. Closson	334	5	Arkose	Valley
4 mi. S of Ellisboro	T. L. Knight	93	7.5	Gneiss	Draw
4 mi. S. of Ellisboro	School	350	7	Gneiss	Flat
4.25 mi.SW of Bethany	L. Bennett	33	5	Gneiss	Valley
Bethany	School	300	8	Gneiss	Flat
3.5 mi. NE of Bethany	A. L. Wall	198	1	Gneiss	Hill

The 112 wells in gneiss in Rockingham County have an average yield considerably less than half that of wells drilled in Triassic rocks, and the average yield per foot of well is only slightly more than half as great. It appears probable, therefore, that the Triassic is a better aquifer than the gneiss in Rockingham County. However, the difference probably is not nearly so great as the summary of data (page 92, Bulletin No. 55) appears to indicate, because many of the wells in the Triassic rocks were drilled for industries and municipalities, whereas most wells in the gneiss were drilled for domestic supplies.

At a few places, wells in the gneiss have been somewhat unsuccessful. . .

Wells on hills yield less than half as much as wells at other locations, and wells in valleys and draws have an average yield per foot of well more than 3 times as great as that of wells drilled on hills. . . Wells in Triassic rocks (41) yield an average of 15.6 gallons a minute, which is much higher than the yield of the other wells in Rockingham County (116) but is only slightly higher than the average for all wells in the Greensboro area. One characteristic of wells in the Triassic is that many of them fail to hold up to the capacity indicated by the test made at the time the well is drilled. . .

In order to determine more accurately the rate at which a well will yield over a long period of time, pumping tests of wells in the Triassic should be of long duration and the well should be pumped at several different rates, accurate measurements being made of the drawdown at the different rates. The water level should be measured for several hours after pumping ceases in order to determine the rate of recovery.

Forsyth County

Location	Owner	Depth of well (ft.)	Yield (g.p.m.)	Chief Aquifer	Topographic location
4 mi. S of Belew Creek	H. F. VonHoy	40	2	Gneiss	Slope
2.25 mi. S of Belew Creek	H. T. Lewis	126	0.25	Gneiss	Hill
1 mi. NE of Walkertown	J. H. Clement	147	25	Gneiss	Hill
Walkertown	School	453	15	Gneiss	Draw
2 mi. W of Walkertown	Camp Lasater	330	6	Gneiss	Valley
3 mi. SW of Walkertown	School	140	8-10	Gneiss	Hill
Kernersville	Town	580	10	Granite	Flat
Kernersville	Adams Mills	308	18	Granite	Slope
Kernersville	Vance Knitting Co.	185	9	Granite	Flat
2 mi. SE of Kernersville	R. J. Reynolds Co.	335	35	Granite	Draw
2 mi. S of Kernersville	J. E. Smith	100	20	Gneiss	Slope

The average yield of wells in gneiss in Forsyth County (107) is 20 gallons a minute, more than $2\frac{1}{2}$ times as great as the average yield of wells in granite (9). However, the average depth of wells in gneiss is also somewhat greater, so that the difference in average yield per foot of wells between wells in gneiss and wells in granite is less. . . .

The 37 wells drilled on hills have an average yield less than half that of wells drilled at other locations (79), and the average yield per foot of well is only slightly more than half as great as it is for wells drilled at other locations. . . . Draws are the best location in which to drill wells. Although the average yield of wells in draws is less than the average yield of wells drilled in valleys, the average yield per foot of well is 39 percent greater.

Stokes County

Location	Owner	Depth of well (ft.)	Yield (g.p.m.)	Chief Aquifer	Topographic location
Ashbury	S. P. Joyce	213	5	Granite	Flat

1.25 mi. E of Ashbury	Benton Joyce	93	1-2	Granite	Hill
1 mi. S of Ashbury	Bill Simmons	101	3-4	Granite	Slope
3 mi. S. of Ashbury	F. V. Dearmin	95	3	Gneiss	Slope
2½ mi. E of Francisco	W. S. Hart	84	5	Gneiss	Slope
1.5 mi. W of Lawsonville	J. C. Mabe	121.5	0.5	Schist	Slope
3.75 mi. SE of Lawsonville	Mrs. W.R. Priddy	150	3	Schist	Hill
3.25 mi. Se of Lawsonville	Jess Priddy	75	10	Schist	Hill
3.5 mi. N of Gap	S. E. Willard	150	2-3	Gneiss	Draw
3.5 mi. N of Gap	Gaston Coffer	84	5	Gneiss	Draw
0.25 mi. S of Capella	J. S. Robertson	142	15	Schist	Slope
2.25 mi. SE of Capella	J. P. Tuttle	102	10	Gneiss	Slope
2 mi. NE of Mountain View	W. W. Terry	115	2.3	Gneiss	Hill
Mountain View	R. W. Burr	140	10	Gneiss	Slope
1.75 mi. SW of Meadows	J. W. Young	101	7	Gneiss	Slope
0.5 mi. N of Meadows	C. H. Davis	160.5	17.5	Gneiss	Hill
Meadows	J. W. Moorefield	76	20	Gneiss	Valley
0.5 mi. W of Pine Hall	Brick Plant	75	5	Shale	Valley
2.25 mi. SW of Pine Hall	Brick Plant	95	10	Conglomerate	Valley
2.25 mi. SW of Pine Hall	Brick Plant	45	10-15	Sand	Valley
Walnut Cove	Ice Plant	120	8	Shale	Slope
Walnut Cove	Town	1027	150	Triassic	Valley
1.5 mi. W. of Walnut Cove	B. P. Bailey	140	8-10	Triassic	Slope
3 mi. N of Germanton	Clifton Jones	142	15	Gneiss	Ridge
2.75 mi. NW of Germanton	Harvey Browder	100	5	Gneiss	Slope
4 mi. W of Germanton	W. E. Tuttle	138	1	Gneiss	Hill

Drilled wells in Stokes County have the lowest average yield and lowest average yield per foot of well of the six counties in the Greensboro area. Probably the chief reason for this is that nearly all drilled wells in Stokes County are used for domestic purposes, and only small yields are needed. Another reason may possibly be that drilled wells in Stokes County are used chiefly at places where water has been difficult to obtain from dug wells, and, therefore, most of the wells have been drilled in areas which are poor water producers.

The average depth of wells in Stokes County (100) is 123 feet, 13 feet more than the average depth of wells in Caswell County (105), which has the lowest

average depth of wells of any county in the area. Stokes County has a larger proportion of domestic wells than Caswell County, and, therefore, the wells should have a smaller average depth. However, Stokes County is more rugged than Caswell County, and the depth to the water table is considerably greater; thus, the average depth of well is greater.

Slightly more than half of the wells were drilled in gneiss, and slightly more than one-fourth were drilled in quartzite and schist. The average yield of wells in the quartzite and schist is slightly greater than in the gneiss, but the average yield per foot of well is identical (.042 g.p.m.). This fact is significant because it suggests that the quartzite and schist is just as good an aquifer, in Stokes County, as the gneiss. This is interesting in view of the fact that wells in gneiss in the entire area (350) have an average yield more than twice as great as those in quartzite (27) and an average yield per foot of well of 76 percent greater. . .

Halifax and Northhampton Counties - - Information regarding these two counties, which lie partially within the Roanoke River Basin; Edgecombe and Nash Counties, the greater parts of which lie in the Tar River Basin; and Wilson County, which lies wholly in the Neuse River Basin, may be found in "Bulletin No. 51, Ground Water in the Halifax Area, North Carolina", by M. J. Mundorff, published in 1946 by the North Carolina Department of Conservation and Development in cooperation with the Geological Survey, United States Department of the Interior. The following material is extracted from Bulletin No. 51.

Halifax County

Ground Water - - Nearly all domestic water supplies, a number of industrial supplies, and four of the six municipal supplies are obtained from wells. The principal source of domestic supplies is shallow wells.

In the western part of the county, most of the wells are dug and are from 30 to 60 feet deep. These wells yield water from the weathered crystalline bedrock or from the sandy clays of the high-level gravels, or from the Brandywine or Coharie formations. Through the central part of the county, both dug and bored wells are used. Bored wells are used mainly where the terrace deposits are thick and permeable enough to furnish a satisfactory supply without the necessity of depending on the larger storage capacity of the dug wells. Where the material is very fine and clayey and of very low permeability, dug wells predominate. Through the eastern part of the county, bored and driven wells are most common. A few dug wells are also used in this area, especially where the terrace deposits contain a considerable amount of clay. . . .

In that part of the area lying west of U. S. Highway 301, most of the drilled wells obtain their water from the crystalline bedrock, and a few get their water from relatively shallow sands and gravels at the base of the terrace deposits. Of about 65 wells drilled in the crystalline rock, only 3 or 4 yielded less than 2 gallons a minute. All of these wells are in granite; 3 of them at the Roanoke Rapids County Club are in an unproductive area, because the granite is at, or within, a few feet of the surface and is unweathered and unjointed. Few of the wells in the crystalline rocks yield more than 20 or 25 gallons a minute, and, if larger supplies are needed, the chances are that more than one well will be necessary. All of the failures were in granite, and, in general, the wells in the slate, schist, and gneiss yield more satisfactory supplies than in the granite. Some of the wells obtain fairly large supplies from the weathered and disintegrated bedrock, which overlies the solid rock, and it is probable that more wells obtain their water from this zone than the reported records indicate. One of the most

difficult areas in which to obtain adequate municipal and industrial supplies is in the area along the Fall Zone from Weldon through Halifax and Enfield. It appears that relatively shallow wells are the most satisfactory, either utilizing a number of well points in a "well field", which can be pumped by one centrally-located pumping plant, or by using one or more gravel-walled wells. . . .

A few miles east of the area west of U. S. Highway 301, satisfactory supplies have usually been obtained from wells drilled into the lenticular sand beds of the Cretaceous Strata. As these strata probably pinch out at, or near Enfield and Halifax, it is quite thin for two or three miles eastward. However, it thickens rapidly, being at least 170 feet thick at the Caledonia State Prison Farm. Large supplies probably can be obtained by properly constructed wells in the Cretaceous Strata in the eastern one-third of the county. The strata are lenticular, and the fact that satisfactory wells are obtained at a given depth in a certain locality does not assure that permeable sand strata will be penetrated at the same depth some distance away. However, in this area, conditions are favorable for penetrating a permeable lens of sand in the Cretaceous at some depth.

A few wells, from 40 to 80 feet deep, obtain their water from the Yorktown formation, but usually even the more sandy strata contain so much clay as to be nearly impermeable. However, two of the wells at Scotland Neck, which apparently end in the Yorktown formation, are gravel-walled wells and yield very satisfactory quantities of water. Most domestic wells ending in this formation yield only small amounts of water, and often the water has bad taste and color.

Records of Wells

Location	Owner	Depth of well (ft.)	Chief Aquifer	Yield (g.p.m.)
Littleton	Bottling Plant	67	Gneiss	12
Littleton	Mrs. J. Johnston	158	Gneiss	12
Littleton	High School	67	Gneiss	6
Roper Springs	Sterling Hamiell	48	Sand & Gravel	5
Between Roanoke Rapids & Littleton	New Hope School	97	Schist	12
Roanoke Rapids	C. T. Johnston	65	Schist	100
Roanoke Rapids	J. E. Mathews	338	Slate	23
Roanoke Rapids	Ice Plant	65	Gravel	24
Roanoke Rapids	Rosemary Mfg.Co.	499	Rock	6
Roanoke Rapids	Roanoke Mill Co.	85	Gravel	10-15 (not use
Roanoke Rapids	Halifax Paper Co.	478		
Roanoke Rapids	Roanoke Mill Co.	86	Gravel	25 (not use
Roanoke Rapids	Country Club	200	Granite	1.5 (not use
Weldon	Brick Works	30	Sand	1-2
Weldon	E. W. Batchelor	60	Granite	25
Halifax	County Home	207	Schist	20
Halifax	Prison Camp	190	Schist	20
Halifax	Town	135	Sand	31
Halifax	Town	51	Sand	15
Halifax	Town	49	Sand	15
Halifax	M. W. Perry	315	Rock	20-25
Halifax	Grade School	204	Rock	20
Halifax	Milling Co.	61	Schist	7-8
Tillery	State Prison Farm	216	Sand	75
Tillery	School	158	Shellrock	7

Tillery	Wm. Davis	25	Gravel	10
Tillery	Lee Johnson	33	Sand & Gravel	10
Hills X Roads	L. G. Barnhill	51	Sand	4
Scotland Neck	R. J. Madery	160	Sand	10
Scotland Neck	High School	55	Sand & Gravel	20
Scotland Neck	Town	59.5	Sand	205
Scotland Neck	Town	96	Sand	200
Scotland Neck	Town	80	Sand	75
Scotland Neck	Ice Plant	25	Sand	5-10
Palmyra	B. B. Everett	176	Sand	10
Palmyra	B. B. Everett	120	Sand	10
Hobgood	City	107	Sand	19
Hobgood	L. F. Whitehurst	100	Sand & Mica	10
Hobgood	Mrs. R. Burnett	140	Sand & Mica	50
Hobgood	L. F. Whitehurst	120	Sand & Mica	10
Hobgood	School	105	Black sand	20

Northampton County

Ground Water - - Practically all of the water used in Northampton County is taken from the ground, but there are no very large users of ground water.

Most domestic supplies are obtained from dug, bored, or driven wells, 10 to 70 feet deep. The shallow wells generally obtain their supplies from the sand, gravels, and clays of the terrace deposits or from the disintegrated and and broken crystalline rocks. Most of the drilled and jetted wells obtain their supplies from the sands of the Cretaceous deposits, with a few getting their supplies from the Yorktown formation. . .

In the extreme western part of the county, dug wells predominate, with a few drilled wells near Camps Store and Vultare. Most of the dug wells in this section obtain their supplies from the gravelly and sandy clays of the Brandywine formation and the high-level gravels, or from the broken and disintegrated material of the upper part of the crystalline bedrock. Dug wells are used because the low permeability of the strata requires large storage capacity, and the heterogeneity of the material makes it difficult to bore or drive wells.

Near Garysburg, dug wells are not satisfactory because of a fine layer of sand which causes caving. Most of the wells are bored or drilled and obtain their water from the sand, gravel, and clays of the Coharie and Sunderland formations, or from the disintegrated crystalline rocks just beneath the terrace deposits.

East of Garysburg, bored and driven wells predominate. At Gumberry, most wells are driven to depths of about 30 feet and obtain their water from sand near the base of the Sunderland formation. . . Most of the wells around Jackson are bored or driven to moderate depths. There are a few drilled wells in and around Jackson, but some of these wells were unsuccessful. In that area, the Cretaceous strata consists mostly of fine sand and chocolate-colored clays which are relatively permeable. The successful wells at Jackson penetrate permeable sands which probably are lenticular and of limited extent.

Records of Wells

Location	Owner	Depth of well (ft.)	Chief Aquifer	Yield (g.p.m.)
Vultare	J. A. Bradley	107	Gneiss	5
Vultare	School	87	Gneiss	15
Vultare	Mrs. Mollie King	93	Gneiss	6
Camps Store	School	103	Granite	7
Camps Store	Gaston High School	87	Slate	30
Camps Store	G. A. Brewer	48	Sand	2
Gumberry	C. P. Gay	67	Sand	5
Garysburg	Mrs. S. S. Suiter	128	Bedrock	8
Garysburg	Robert Allen	67	Bedrock	10
Garysburg	Wilson Glasgow	55	Bedrock	6
Garysburg	R. G. Young	55	Bedrock	4
4 mi. SE of Garysburg	W. J. Long	65	Sand	12
Jackson	State Prison Camp	248	Sand	14
Jackson	H. L. Joyner	168	Sand	12-15
Jackson	Town	40	Sand	75 (6 wells
Jackson	George Burgwyn	97	Sand	6-8
Jackson	Town	260	Sand & Gravel	20
Rich Square	School	165	Sand, hard	15
Rich Square	W. C. Worrell	22	Sand, fine	1-2
Rich Square	Town	100	Sand	140
Rich Square	Town	70	Sand	120
Rich Square	Robert Griffin	70	Sand	250
Rich Square	Coal & Ice Co.	48	Sand	40
Rich Square	Coal & Ice Co.	28	Sand	25-30

Public Water Supplies - Descriptions and chemical character of public supplies of water, both surface water and ground water, are contained in Chapter II of this publication.

Chemical Character of Surface Waters - The following material, taken from Bulletin 52, Volumes 1 - 10, inclusive, published by the North Carolina Department of Conservation and Development and prepared cooperatively by the Geological Survey, U. S. Department of the Interior, comprises analyses of samples of surface waters in the Roanoke River Basin in North Carolina, collected, during the period from October 1, 1944 to September 30, 1954, daily for some stations, and monthly for other stations, at or near points where continuous stream measurement stations were maintained. In addition to the daily and monthly samples, samples were also collected periodically at miscellaneous stream-measurement sites. This additional data made it possible to predict the chemical character of the streams at various points within the Roanoke River Basin.

Dan River near Francisco

Date	7-21-47	Na + K	4.0
Mean discharge (c.f.s.)	169	Bicarbonate	17
Color	26	Sulfate	2.1
pH	5.9	Chloride	1.2
Silica	8.7	Fluoride	.1
Iron	.03	Nitrate	.4
Calcium	2.2	Dissolved solids	28
Magnesium	1.0	Total hardness	10

Town Fork Creek at Walnut Cove

Date	11-21-49	4-15-50	6-5-51	8-9-52	9-10-53
Discharge (c.f.s.)	65.1	68.9	37.8	36.4	20.6
Silica	22				
Iron	.02				
Calcium	5.8				
Magnesium	2.4				
Na + K	5.7				
Bicarbonate	36	38	41	38	34
Sulfate	3.1	3	2	2	5
Chloride	2.5	2.2	3.0	2.2	2.0
Fluoride	0.1				
Nitrate	0.1				
Dissolved Solids	60				
Total hardness	24	24	27	25	24
Specific conductance	73.2	73.4	86.5	75.0	69.4
pH	7.0	7.0	6.8	7.1	7.0
Color	5				

Dan River near Walnut Cove

Date	2-28-47	Na + K	4.4	Nitrate	.2
pH	7.2	Bicarbonate	16	Dissolved solids	31
Silica	10	Color	36	Total hardness	10
Iron	.03	Sulfate	3.0		
Calcium	2.3	Chloride	1.8		
Magnesium	1.0	Fluoride	.2		

Dan River at Pine Hall

Date	4-4-46	Bicarbonate	18
Suspended matter	14	Sulfate	2.6
Color	4	Chloride	1.2
Silica	11	Fluoride	.1
Iron	.02	Nitrate	.2
Calcium	3.1	Dissolved solids	35
Magnesium	1.4	Total hardness	14
Na + K	2.8		

Mayo River near Price

	Average of daily samples, 10-1-48 to 9-30-49, incl.	Sample collected, 4-20-49
Discharge (c.f.s.)	319	419
Temperature	57	
Suspended matter	79	
Oxygen consumed		
Unfiltered	4.0	
Filtered	1.9	
Color	5	2
pH	6.8	6.9
Specific conductance	45.7	38.3
Silica	15	12
Iron	.05	.02
Calcium	3.8	3.1
Magnesium	1.6	.3
Na + K	3.6	5.2
Bicarbonate	23	19
Sulfate	2.4	2.5
Chloride	1.6	1.2
Fluoride	.1	.1
Nitrate	.3	.2
Dissolved solids	41	35
Total hardness	16	9

Mayo River at Stoneville

Date	7-21-47	Bicarbonate	20
Color	22	Sulfate	2.4
pH	6.3	Chloride	1.1
Silica	12	Fluoride	.2
Iron	.03	Nitrate	.6
Calcium	2.9	Dissolved solids	37
Magnesium	1.4	Total hardness	13
Na + K	3.9		

Dan River near Wentworth

	Average of daily samples, 10-1-50 to 9-30-51	Sample collected, 10-23-44
Mean discharge (c.f.s.)	996	1,340
Temperature, F.	59	
Suspended matter	123	129

Dan River near Wentworth (continued)

Oxygen consumed		
Unfiltered	4.8	
Filtered	2.2	
Color	6	7
pH	6.8	
Specific conductance	49.7	
Silica	14	12
Iron	.05	.04
Calcium	4.0	3.2
Magnesium	1.4	1.2
Na + K	4.4	5.6
Bicarbonate	22	22
Sulfate	3.5	3.8
Chloride	2.2	2.1
Fluoride	0.1	.0
Nitrate	0.3	.2
Dissolved solids	42	40
Total hardness	16	13

Smith River at Spray

Samples collected	7-21-47	8-17-48	1-19-49	6-38-49	Av. Monthly 1940-1949
Mean discharge (c.f.s.)	298	310	588	1040	594
Color	26	5	7	6	4.8
pH	6.3	7.0	6.8	6.4	6.9
Specific conductance			60.5	49.1	66.2
Silica	13	7.0	14	13	15
Iron	.03	.03	.01	.02	.07
Calcium	4.9	6.3	4.1	4.1	5.4
Magnesium	2.1	2.3	1.9	1.6	2.0
Na + K	4.5	4.8	4.1	3.7	5.2
Bicarbonate	28	35	24	23	28
Sulfate	3.5	2.6	3.3	3.2	3.7
Chloride	1.9	2.6	2.4	1.8	3.1
Fluoride	.1	.1	.1	.0	.1
Nitrate	1.3	.4	.4	.2	.7
Dissolved Solids	46	44	45	42	50
Total hardness	21	25	18	17	22

Hyco River near Roxboro

	11-17-49	4-14-50	8-23-40	7-12-51	8-9-52	10-29-52	4-24-53
Samples collected	18.4	21.1	3.23	5.42	8.91	3.93	26.2
Discharge (c.f.s.)	21						
Iron	.11						
Calcium	10						
Magnesium	4.7						
Na + K	9.2	64	92	71	53	71	60
Bicarbonate	59	64	92	71	53	70	60
Sulfate	6.3	4	3	3	2	4	5
Chloride	6.4	6.5	4.8	5.5	4.5	6.8	5.8
Fluoride	.1						
Nitrate	.1						

	11-17-49	4-14-50	8-23-40	7-12-51	8-9-52	10-29-52	4-24-53
Dissolved solids	88						
Total hardness	44	51	49	50	39	53	42
Specific conductance	129	134	134	138	109	139	126
pH	6.9	7.0	7.2	7.2	7.2	7.1	7.0
Color	8						

Roanoke River near Roanoke Rapids

Samples collected	1-7-46	7-27-47	Average daily, 1948-1949
Discharge (c.f.s.)	10,400	8,140	11,990
Temperature, F.			62
Suspended matter	24		106
Oxygen consumed			
Unfiltered			4.9
Filtered			2.6
Color	5	34	6
pH		6.4	6.9
Specific conductance			81
Silica	14	14	13
Iron	.01	.02	.06
Calcium	5.0	6.6	6.4
Magnesium	2.3	2.5	2.6
Na + K	4.5	9.0	5.7
Bicarbonate	26	37	33
Sulfate	5.7	7.7	6.2
Chloride	2.8	4.8	3.4
Fluoride	0	.2	.1
Nitrate	.6	.9	.6
Dissolved solids	49	67	58
Total hardness	22	27	27

Dan River at Leaksville

Samples collected	Average daily, 1944-1945	7-21-47	8-17-48	1-19-49	6-27-49
Mean discharge (c.f.s.)	1347	895	658	1160	961
Temperature, F.	58				
Suspended matter	142				
Oxygen consumed					
Unfiltered	4.4				
Filtered	2.3				
Color	7	22	4	2	7
Silica	13	12	14	15	12
Iron	.04	.03	.02	.01	.05
Calcium	3.6	3.0	4.3	4.3	3.4
Magnesium	1.5	1.3	1.4	1.6	1.2
Na + K	4.3	4.3	7.6	2.5	4.3
Bicarbonate	22	20	23	22	19
Sulfate	3.0	2.8	3.5	2.8	2.5
Chloride	1.7	1.5	1.8	2.4	1.8
Fluoride	.1	.1	.1	.0	.2
Nitrate	.4	.8	.4	.3	1.9
Dissolved solids	41	36	44	44	38
Total hardness	15	13	16	19	13

	Average daily, 1944-1945	7-21-47	8-17-49	1-19-49	6-27-49
pH		6.2	6.9	6.9	6.1
Specific conductance				49.4	40.3

South Country Line Creek near Yanceyville

Samples collected	11-21-49	4-15-50	8-23-50	7-12-51	8-0-52	4-24-53
Discharge (c.f.s.)	5.04	5.79	0.31	0.488	1.27	7.13
Silica	20					
Iron	.03					
Calcium	12					
Magnesium	6.5					
Na + K	9.5					
Bicarbonate	66	71	70	77	59	60
Sulfate	11	6	5	4	3	6
Chloride	8.2	7.8	5.5	5.8	5.0	5.8
Fluoride	.1					
Nitrate	.1					
Dissolved solids	101					
Total hardness	57	59	54	63	49	49
Specific conductance	159	166	143	152	127	139
pH	7.3	6.9	6.8	6.9	6.7	6.8
Color	7					

Chockyott Creek at Weldon

Sample collected	7-22-47	Bicarbonate	10
Color	74	Sulfate	7.9
pH	5.1	Chloride	3.6
Silica	6.5	Fluoride	0
Iron	.08	Nitrate	.2
Calcium	3.0	Dissolved solids	51
Magnesium	1.2	Total hardness	12
Na + K	4.2		

Roanoke River at Weldon

Sample collected	7-22-47	Bicarbonate	53
Color	34	Sulfate	7.7
pH	6.8	Chloride	4.0
Silica	12	Fluoride	.2
Iron	.01	Nitrate	1.0
Calcium	12	Dissolved solids	81
Magnesium	2.2	Total hardness	39
Na + K	8.9		

Roanoke River near Scotland Neck

Samples collected	Average daily, 1944-1945	7-22-47	6-8-49
Discharge (c.f.s.)	10,640	6,240	5,200
Temperature, F.	61		
Suspended matter	104		
pH		6.6	6.5
Oxygen consumed			
Unfiltered	9.3		
Filtered	5.0		

	Average daily, 1944-1945	7-22-47	6-8-49
Color	20	30	7
Silica	13	14	14
Iron	.18	.03	.06
Calcium	6.9	7.5	6.7
Magnesium	2.5	2.1	3.0
Na + K	9.7	10	8.4
Bicarbonate	41	42	43
Sulfate	7.3	7.1	5.6
Chloride	5.9	4.2	4.0
Fluoride	.1	.2	.1
Nitrate	2.2	1.0	.3
Dissolved solids	76	68	64
Total hardness	28	27	29

Ready Branch near Williamston

Sample collected	12-14-49	4-18-50	9-3-50	6-5-51	10-25-51	9-11-52	6-4-53
Discharge (c.f.s.)		5.11	2.73	0.822	2.44	2.56	1.21
Color	32		28				
pH	7.0	6.7	6.8	6.5	6.5	6.9	6.5
Specific conductance	85	88	80	77	90	84	74
Silica	12		13				
Iron	.11		.12				
Calcium	5.6		5.4				
Magnesium	1.7		1.3				
Na + K	6.6		6.9				
Bicarbonate	21	26	19	24	28	22	19
Sulfate	5.5	4	4.4	3	3	5	5
Chloride	8.5	9.8	9.2	7.8	8.8	7.5	8.2
Fluoride	.1		.0				
Nitrate	.2		1.0				
Dissolved solids	67		62				
Total hardness	21	20	19	19	19	20	20

Roanoke River at Williamston

Sample collected	7-22-47	Bicarbonate	44
Color	28	Sulfate	8.1
pH	7.1	Chloride	4.9
Silica	14	Fluoride	.2
Iron	.05	Nitrate	1.4
Calcium	8.5	Dissolved solids	71
Magnesium	2.6	Total hardness	32
Na + K	9.8		

Cashie River at Windsor

Sample collected	7-22-47	Bicarbonate	13
Color	80	Sulfate	8.8
pH	5.6	Chloride	4.2
Silica	12	Fluoride	0
Iron	.46	Nitrate	0
Calcium	3.9	Dissolved solids	70
Magnesium	1.3	Total hardness	15
Na + K	4.9		

Roquist Creek near Windsor

Sample collected	4-22-49	4-19-50	10-11-50	6-6-51
Discharge (c.f.s.)	16.2	6.1		0.183
Color	55			
pH	6.0	6.0	6.4	6.5
Specific conductance	61	67	84	104
Silica	5.6			
Iron	.66			
Calcium	4.6			
Magnesium	1.6			
Na + K	5.8			
Bicarbonate	22	16	30	28
Sulfate	2.6	1	2	3
Chloride	7.0	9.2	8	10
Fluoride	0			
Nitrate	.1			
Dissolved solids	62			
Total hardness	18	18	25	22

	Roanoke River above Plymouth	Roanoke River Below Plymouth
Sample collected	3-19-46	4-10-46
Suspended matter		28
Color	8	16
Silica	12	12
Iron	.16	.07
Calcium	7.4	10
Magnesium	2.8	4.6
Na + K	5.5	25
Bicarbonate	35	66
Sulfate	5.7	7.4
Chloride	4.5	25
Fluoride	.2	.1
Nitrate	.4	.1
Dissolved solids	57	120
Total hardness	30	44

Conaby Creek at Plymouth

Sample collected	2-25-49	Bicarbonate	12
Color	45	Sulfate	9.2
pH	6.1	Chloride	6.2
Specific conductance	59	Fluoride	.1
Silica	4.7	Nitrate	.3
Iron	.17	Dissolved solids	57
Calcium	3.8	Total hardness	22
Magnesium	3.0		
Na + K	3.2		

Roanoke River Basin Pollution Survey Report - At a meeting of the State Stream Sanitation Committee on November 5, 1956, the Committee, after discussion of the report and explanation of the findings during the study and the suggested classifications for the waters, adopted the report as presented and agreed to hold public hearings regarding assignment of classifications to the waters in the Roanoke River Basin at Yanceyville and Halifax on January 15, 1957 and January 16, 1957, respectively. The report contains information regarding sources of pollution in the upper and lower sections of the basin as follows.

Dan River and Tributaries - There is considerable use of the streams in this area for waste disposal. There are nineteen significant sources of sewage and industrial wastes tributary to these waters and in many instances such discharges are resulting in conditions that seriously jeopardize the other necessary uses which must be made of the streams. The total sewage and waste load tributary to the streams, expressed in the population equivalent (P.E.), is estimated to be 66,955 of which 44,110 is due to industrial waste discharges. The individual sources of pollution are discussed as follows:

Town of Walnut Cove - The municipal sewer system serves an estimated population of 1,100 and discharges the raw sewage into Town Fork Creek. This pollution is significant from the standpoint of its effects on the receiving stream.

Town of Stoneville - The municipal sewerage system serves an estimated connected population of 530. Primary treatment is provided by two Imhoff tanks and one septic tank. The effluents of these tanks are discharged into three unnamed branches which, in turn, empty into Buffalo Creek, Boaz Creek, and Mayo River. If these facilities are properly operated and maintained, they should provide adequate treatment for the sewage from the population now connected.

Town of Mayodan - The municipal sewerage system serves an estimated connected population of 2,000 as well as receiving the domestic sewage from the Washington Mills. Secondary treatment is provided before the sewage is discharged into the Mayo River. The population equivalent of this effluent is estimated to be 500.

Washington Mills Company, Mayodan - This plant discharges an estimated 40,000 g.p.d. of untreated industrial waste into the Mayo River. This waste has an estimated population equivalent of 2,400.

Town of Madison - This municipal sewerage system serves an estimated population of 1,200. Primary treatment is provided before the sewage is discharged into the Dan River. The population equivalent of this waste is estimated to be 900. This pollution is significant from the standpoint of its effects on the water supply at Leaksville.

Town of Spray - This municipal sewer system serves an estimated connected population of 5,000 persons. The wastes collected by this system are discharged without treatment into the Smith River and contribute significant bacterial pollution to the stream as well as contributing oxygen consuming materials and solids to the stream.

Fieldcrest Mills, Spray - Three of Fieldcrest Mills' plants are located at Spray. Wastes from these plants are discharged without treatment into

the Smith River. These wastes add a significant amount of color and oxygen consuming material to the stream. The population equivalents of these wastes are estimated to be as follows:

Fieldcrest Mills - Electric Blanket Mill - 730.
Fieldcrest Mills - Rayon Mill - 330.
Fieldcrest Mills - Bleach and Finish Mill - 8,280.

Leaksville Woolen Mills, Inc. discharges untreated wastes into Smith River. The population equivalent of these wastes is estimated to be 500.

Town of Leaksville - This municipal sewer system discharges untreated sewage from an estimated population of 5,080 persons into the Dan River. These wastes affect the river deleteriously by increasing the bacterial pollution, and contributing color, solids, and oxygen consuming material to the stream.

Fieldcrest Mills, Leaksville - This Company operates two plants at Leaksville that discharge untreated sewage and industrial wastes into the Dan River. These wastes add a large amount of color and oxygen consuming material to the river. The population equivalents of these wastes are estimated to be as follows:

Fieldcrest Mills - Kranstan Rug Mill - 25,000.
Fieldcrest Mills - Bedspread Mill - 1,200.

Town of Draper - This municipal sewer system discharges untreated sewage from an estimated population of 800 persons into the Dan River. The raw sewage contributes solids and bacterial pollution to the stream.

Fieldcrest Mills, Draper - The Company operates two plants in Draper that discharge both sewage and industrial wastes into the Dan River. The sewage receives primary treatment; however, the industrial wastes receive no treatment before being discharged to the stream. The population equivalent of the wastes from each of these plants is estimated to be as follows:

Fieldcrest Mills - Blanket Mill - 1,000.
Fieldcrest Mills - Sheeting Mill - 700.

City of Reidsville - The public sewerage system serves an estimated population of 10,000 persons; however, all of the wastes collected by this system are not discharged into the waters of the Roanoke River Basin. Waste collected from an estimated population of 4,000 persons is given primary treatment and discharged into Wolf Island Creek and Hogans Creek. The City has employed engineers to study the waste disposal problem and to submit plans for the renovation of their waste disposal facilities.

Yanceyville Sanitary District - This sewerage system provides primary treatment for the sewage collected from an estimated population of 800 persons. This plant also serves two schools having a combined enrollment of approximately 1,100 students. The treatment facilities are overloaded, since the Imhoff tank was designed to serve a population of only 600 persons.

Town of Roxboro - The Roxboro sewer system serves the Town of Roxboro, the communities of Brooksdale, Longhurst, and Cavel as well as industries in the area. It is estimated that the sewer system serves a

population of 6,250 persons and also discharges approximately 600,000 g.p.d. of industrial waste having an estimated population equivalent of 4,000. These wastes are discharged without treatment into Marlowe Creek and produce an odorous as well as an unsightly condition. The heavy pollutional load renders the stream unsuitable for livestock water and irrigation.

Lower Roanoke River and Tributaries - Streams in this section receive an extensive pollution load made up of both domestic sewage and industrial waste. In many instances these discharges are resulting in conditions that seriously jeopardize the necessary uses which must be made of the receiving streams. The total sewage and waste load tributary to the streams, expressed as population equivalent (P.E.), is estimated to be 622,500 of which 497,000 is due to industrial waste discharges. The individual sources of pollution are discussed as follows:

Town of Henderson - The municipal sewerage system of Henderson serves an estimated population of 11,000 persons. The waste receives primary treatment before being discharged into Nutbush Creek. The effluent from this treatment plant produces septic conditions in Nutbush Creek that result in an odorous and unsightly stream, as well as contributing an enormous number of sewage (coliform) bacteria to the stream.

Town of Norlina - Even though the Town has no sewage collection sytem, nevertheless a sewage disposal problem exists. Several privately owned septic tanks, including the school, the Town Hall, one restaurant, one beauty shop, one drugstore and other commercial establishments, discharge effluents through a filter trench to a catch basin. The effluent from the catch basin flows into a ditch that empties into the drainage system of Ellington's Creek. This situation should be corrected.

Town of Littleton - This municipal sewerage system serves an estimated population of 1,250 persons. The system includes four small septic tanks that were built in 1922 and designed to serve a total population of approximately 300 persons. All four of these units are located on different streams; only two of these being in the Roanoke River Basin. Sewage from a population of approximately 150 persons is collected in two small septic tanks and discharged into West Littleton Branch and Bagley Academy Branch, both streams being tributary to Little Stonehouse Creek. Nuisance conditions exist in both of these branches particularly during hot - dry weather. The Town has employed engineers to study its sewage disposal problems.

McPherson Bottling Co. discharges an estimated 20,000 gallons of process wastes into a ditch that eventually drains into Little Stonehouse Creek. These wastes are primarily the wash waters from the bottle washing machine and have an estimated population equivalent of 2,800. Since they contain appreciable quantities of oxygen consuming material, their discharge into Little Stonehouse Creek will result in the lowering of the dissolved oxygen concentration in that stream.

Roanoke Rapids Reservoir - Even though no polluting material is discharged into the stream by Roanoke Rapids Reservoir, the dam, with its low level turbine intake structure, is the equivalent of a source of pollution. Water discharged through the turbines is low in dissolved oxygen and at times high in manganese and iron.

Roanoke Rapids Sanitary District - The Roanoke Rapids sewer system serves

an estimated connected population of 9,000 persons as well as several of the industries in the area. The total pollutional load discharged by the Roanoke Rapids sewer is estimated to have a population equivalent of 18,320, of which an estimated 9,687 is attributable to domestic sewage and an estimated 8,633 is attributable to industrial waste. These wastes interfere with essential downstream uses.

Manchester Board and Paper Company discharges an estimated volume of 600,000 gallons per day of untreated industrial waste into the Roanoke River. This waste has an estimated population equivalent of 11,841 and interferes with essential downstream uses.

Roanoke Mills Plant # 1 discharges an estimated volume of 275,000 gallons of untreated industrial waste into the Roanoke River daily. This waste, having an estimated population equivalent of 3,776 is highly colored and high in oxygen consuming materials and interferes with essential downstream uses.

Halifax Paper Company- The United States Public Health Service in co-operation with the State Stream Sanitation Committee studied the volume and characteristics of liquid waste from the Halifax Paper Company during August and September, 1953. Results from this study show that the Halifax Paper Company discharged an average of 17.3 millions of gallons of untreated industrial waste daily into the Roanoke River. The plant study also shows that during the period of study the waste contained 90,000 pounds of 5-day 20°C. B.O.D., or the equivalent of domestic sewage from a population of approximately 540,000 persons. These wastes, not only contain materials that are high in oxygen demand, but they also contain materials that are toxic to fish life when present in sufficient concentrations. As yet these substances have not all been identified, nor has lethal concentrations, as they affect striped bass, been determined. These wastes seriously jeopardize the necessary downstream uses.

During early 1955 certain changes were made at the mill. A second study was made to determine volume and characteristics of the waste. Results of this study showed that the waste load had been reduced by 44% while pulp production had increased by 21%. This reduction in pollution load has not appreciably improved river condition, due to the reduction of dissolved oxygen by upstream impoundments.

Town of Weldon - This municipal sewer system collects sewage from an estimated connected population of 2,400 persons. This waste is discharged without treatment into Smith Branch and Roanoke River.

Town of Halifax - This sewerage system serves an estimated population of 325 persons. The Town uses a septic tank for the treatment of the sewage before it is discharged into Quanky Creek. Primary treatment as provided is adequate for the population that is now bing served provided it is properly operated and maintained. However, the treatment facility of the Town of Halifax was not being properly operated when visited by personnel of the State Stream Sanitation Committee on January 20, 1954.

Caledonia Prison Farm, Halifax County discharges the effluent from its sewage treatment plant to a ditch that drains into the Roanoke River. A cannery and a laundry are operated at the Camp. Wastes from these operations are discharged to the ditch without receiving any treatment. The population equivalent of these wastes is estimated to be 3,400.

Town of Jackson - This municipal sewerage system serves an estimated population of 750 persons. The system includes a treatment plant consisting of primary settling and intermittent sand filter. The effluent is discharged into Lilly Pond Creek. Treatment as provided is adequate if properly maintained and operated. However, when this plant was visited by personnel of the State Stream Sanitation Committee, it was found that the plant was not being properly operated and maintained.

Town of Rich Square - This municipal sewerage system serves an estimated population of 690 persons. The sewage receives primary treatment before being discharged into Bridgers Creek. When this plant was inspected by personnel of the State Stream Sanitation Committee, the sludge drying beds were not being used. At the time of inspection, November 5, 1953, it was evident that the Imhoff tank had been cleaned and the sludge dumped into a drainage ditch and allowed to drain into Bridgers Creek. The allowance of the sludge to drain into the Creek is in contravention of the purpose for which the treatment works were built. With proper operation and maintenance the waste treatment plant as now provided is adequate.

Town of Williamston - This municipal sewage collection system collects the sewage from an estimated population of 4,000 persons. The sewage is discharged without treatment through two outfall sewers into the Roanoke River. This waste lowers the dissolved oxygen content of the river as well as greatly increasing the bacterial count in the stream.

Atlas Plywood Co., Williamston Plant - Wastes from log steaming chambers are discharged to the storm sewer to the Roanoke River. These wastes are highly colored and have an estimated population equivalent of 4,800.

Williamston Packing Co.- Industrial wastes are discharged to a ditch which drains to Sweetwater Creek. These wastes have on occasion resulted in complaints from persons living near the ditch. The population equivalent of these wastes is estimated to be 730.

Town of Plymouth - This municipal sewage collection system collects sewage from an estimated population of 4,650 persons. This sewage is discharged without treatment into the Roanoke River and Conaby Creek. The outfalls that discharge into the Roanoke River serve an estimated population of 3,650 persons, while the outfalls that discharge into Conaby Creek serve an estimated population of 1,000. Nuisance conditions exist near the head of Conaby Creek during hot - dry weather.

North Carolina Pulp Company, Plymouth - This plant discharges an estimated volume of 40 MGD of untreated industrial waste into Welsh Creek and the Roanoke River. This waste contributes a five-day 20°C. B.O.D. load of 45,800 pounds, or a population equivalent of approximately 274,800. The waste discharged into Welsh Creek has a population equivalent of approximately 43,800 whereas the waste discharged directly into the Roanoke River has a population equivalent of approximately 231,000. These wastes, highly colored as well as high in oxygen consuming material, almost completely deplete the dissolved oxygen in the stream during periods of hot - dry weather. Not only are the wastes high in oxygen consuming material, but they contain substances that are toxic to fish life when present in sufficient concentrations. As yet these substances have not all been identified, nor have lethal concentrations been determined.

Atlas Plywood Co., Plymouth Plant discharges wastes from log steaming pit

to a ditch that drains to Roanoke River. These wastes are highly colored and have an estimated population equivalent of 1,400.

Town of Windsor - This municipal sewer system collects the sewage from an estimated population of 1,500 persons. The sewage is discharged without treatment through three outfall sewers into Cashie River. These wastes are of significance as they affect the receiving stream.

Contents of the Report - The report contains a summary (page 7), conclusions (page 9), general description of the basin (pages 25-33), discussion of the survey and statement of general survey findings (pages 35-48), and tables presenting public water supplies, points of significant sources of pollution, and recommended classifications (pages 49-170).

Further action by the Committee - After consideration of views and comments presented at the public hearings indicated previously in this chapter, the Committee will adopt classification of waters in the basin and determine the effective date thereof, on and after which the provisions of Section 143-215.2, General Statutes of North Carolina will be in full force and effect.

General - Information regarding water control; problems of watershed management; the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 2nd Session, approved August 4, 1956); the first annual National Watershed Congress (December 6 and 7, 1954); and the North Carolina Soil Conservation Districts Law, enacted by the 1937 Session of the General Assembly, may be found in Chapter XIII of "Water Resources of North Carolina, Department of Conservation and Development, 1955". The quoted publication comprises Volume I of a series of 11 volumes pertaining to the water resources of the State, of which the material herein, regarding the water resources of the Roanoke River Basin, forms Volume V.

Soil Conservation Practices Accomplished and Contemplated

The data contained in the following tables of "Soil Conservation Practices Accomplished" and "Soil Conservation Practices Contemplated" were furnished by the State Conservationist, Soil Conservation Service, U. S. Department of Agriculture, Raleigh, North Carolina, for the 13 counties, each of which form substantial parts of the area of the Roanoke River Basin lying within the State of North Carolina.

These 13 counties are included in seven Soil Conservation Districts as follows:

Soil Conservation Districts	Counties
Dan River	Caswell, Person, Rockingham, and Stokes
Tar River	Granville and Vance
Fishing Creek	Halifax and Warren
Roanoke - Chowan	Bertie and Northampton
Coastal Plain	Martin
Tri-Creek	Forsyth
Pamlico	Washington

Because of the manner in which soil conservation districts were originally organized, some districts include only one county, whereas other districts may contain as many as five counties. The records of the State Conservationist are maintained on a district, and on a county, basis. Consequently, when a county lies partially in one basin and partly in another, it was necessary for the State Conservationist to use estimates instead of actual accomplishments in preparing the tables. He feels sure, however, that the figures indicated on the two tables are accurate enough for all practical purposes.

The large number of "remaining district cooperators", shown on the table of Soil Conservation Practices Contemplated, does not necessarily signify an unwillingness on the part of farmers in those counties to carry out soil conservation plans. On the other hand, it simply means that the small number of Soil Conservation Service technicians available in North Carolina have been unable thus far to work with all of these farmers. The State Conservationist hopes to reach them all as rapidly as possible.

Town Fork Creek Watershed - This watershed, located in the south-central portion of Stokes County and the north-central portion of Forsyth County, is the only watershed in the Roanoke River Basin within North Carolina for which planning assistance has been requested, under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, approved August 4,

SOIL CONSERVATION PRACTICES ACCOMPLISHED

ITEM	UNIT	BERTIE	CASWELL	FORSYTH	GRANVILLE	HALIFAX	MARTIN	NORTHAMPTON	PERSON	ROCKINGHAM	STOKES	SURRY	VANCE	WARREN	WASHINGTON	TOTAL
Closed Drains	Lin.Ft.	24,820	- -	4,619	- -	27,764	549,520	8,836	190	- -	3,681	1,714	- -	152	4,676	625,972
Conservation Crop Rotation	Acres	8,190	35,445	5,980	11,220	10,323	15,827	3,972	22,432	18,485	19,320	2,037	13,379	4,703	2,280	173,593
Contour farming	Acres	2,357	23,591	6,962	5,359	11,344	- -	1,139	23,714	14,157	12,286	1,509	19,750	4,750	- -	126,936
Contour Stripcropping	Acres	136	640	1,693	124	228	- -	15	1,824	3,400	2,898	224	97	- -	- -	11,279
Cover cropping	Acres	4,082	30,081	3,707	5,946	9,924	8,175	7,851	18,467	13,718	8,081	1,612	13,934	2,660	555	128,793
Critical Area Planting	Acres	- -	452	- -	- -	- -	- -	- -	558	853	297	2	26	- -	- -	2,188
Crop Residue Utilization	Acres	3,425	6,547	2,575	1,591	16,385	14,000	8,420	9,488	8,839	6,347	1,193	11,565	2,172	100	92,647
Drainage	Acres	10,148	243	989	104	- -	6,181	2,576	411	998	1,974	56	65	388	2,310	26,443
Group Enterprise	Miles	7	- -	- -	- -	- -	30	6	- -	- -	- -	- -	- -	- -	6	49
Group Enterprise	Cu.Yds.	55,440	- -	- -	- -	- -	237,600	47,520	- -	- -	- -	- -	- -	- -	47,520	388,080
Improvement Cuttings	Acres	5,772	2,284	9,181	1,450	2,106	3,500	1,874	3,680	850	61	825	2,993	348	1,338	36,262
Open Drains	Miles	117	- -	9	1	44	25	60	6	23	72	2	1	4	44	408
Open Drains	Cu.Yds.	585,000	- -	45,000	5,000	220,000	125,000	300,000	30,000	115,000	360,000	10,000	5,000	20,000	220,000	2,040,000
Pasture Planting	Acres	3,104	7,753	4,390	1,358	3,559	2,087	1,481	4,929	7,893	3,346	794	1,127	2,016	372	44,209
Pond Construction	No.	20	164	140	124	60	22	12	212	310	153	16	30	26	- -	1,289
Sprinkler Irrigation Systems	No.	1	6	7	3	2	2	- -	22	23	- -	1	- -	1	- -	68
Sprinkler Irrigation Systems	Acres	- -	130	240	70	42	35	22	- -	380	- -	37	- -	27	- -	983
Terracing	Miles	42	1,805	536	391	699	50	55	799	2,113	801	129	513	676	- -	8,609
Tree Planting	Acres	61	612	125	147	188	29	50	291	3,938	135	22	50	264	16	5,928
Waterway Development	Acres	51	1,464	311	173	553	4	30	693	2,726	1,574	27	337	552	- -	8,495
Wildlife Area Development	Acres	107	144	276	- -	55	- -	73	52	110	331	19	- -	83	- -	1,250
District Cooperators	No.	713	873	1,124	1,237	972	756	648	1,150	924	2,209	1,511	1,074	1,101	468	14,760

SOIL CONSERVATION PRACTICES CONTEMPLATED

ITEM	UNIT	BERTIE	CASWELL	FORSYTH	GRANVILLE	HALIFAX	MARTIN	NORTHAMPTON	PERSON	ROCKINGHAM	STOKES	SURRY	VANCE	WARREN	WASHINGTON	TOTAL
Closed drains	Lin.Ft.	6,371,180	- -	33,331	7,385	2,343,292	2,421,279	620,132	110,310	- -	8,041	11,437	- -	19,912	34,325	11,980,624
Conservation crop-rotation	Acres	47,541	30,947	11,082	21,638	66,617	36,298	39,912	16,850	29,510	38,020	3,507	13,391	32,107	756	388,176
Contour farming	Acres	21,130	40,515	10,845	25,347	42,285	- -	19,056	15,115	38,380	25,942	3,757	14,814	30,674	- -	287,860
Contour stripcropping	Acres	3,894	24,145	7,382	15,136	14,729	101	1,318	5,660	10,580	48,447	1,134	9,196	8,276	- -	149,998
Cover cropping	Acres	5,668	36,749	14,446	24,506	65,425	20,289	13,503	19,815	24,421	29,976	3,534	20,720	17,481	2,069	298,602
Critical Area Planting	Acres	52,330	6,300	- -	350	- -	- -	- -	- -	2,304	2,403	98	15,600	- -	- -	27,055
Crop Residue Utilization	Acres	27,520	15,539	15,231	21,840	721	42,000	12,835	2,502	9,305	3,284	387	6,442	16,908	1,500	200,824
Drainage	Acres	57	1,556	1,171	2,888	148	11,466	14,345	1,470	3,891	12,399	363	1,113	1,474	821	80,625
Group Enterprise	Miles	451,440	- -	- -	- -	1	70	16	- -	- -	- -	- -	- -	- -	10	154
Group Enterprise	Cu.Yds.		- -	- -	- -	7,920	554,400	126,720	- -	- -	- -	- -	- -	- -	79,200	1,219,680
Improvement Cuttings	Acres		50,829	8,910	11,913	1,538	1,421	24,208	11,371	17,710	20,811	4,491	18,085	24,728	1,834	864,286
Open Drains	Miles		31	27	50	3	66	360	20	289	150	31	15	88	46	1,709
Open Drains	Cu.Yds.		155,000	135,000	250,000	15,000	330,000	1,800,000	100,000	1,445,000	750,000	155,000	75,000	440,000	230,000	8,545,000
Pasture Planting	Acres		18,263	4,610	260	41	1,368	5,229	8,251	15,556	7,369	1,939	4,711	2,614	51	76,652
Pond Construction	No.		439	284	14	1	53	37	538	708	584	53	155	382	3	3,414
Sprinkler Irrigation Systems	No.		517	74	4	3	128	23	457	688	- -	29	214	173	- -	3,326
Sprinkler Irrigation Systems	Acres		6,587	2,106	96	200	3,843	464	- -	12,921	- -	563	3,120	4,980	- -	3,251,732
Terracing	Miles		3,335	92	61	79	376	762	1,901	2,559	3,896	58	2,903	2,834	- -	19,802
Tree Planting	Acres		7,950	908	43	13	227	1,335	868	942	2,185	376	761	210	30	18,448
Waterway Development	Acres		2,784	1,242	76	1	94	70	1,168	2,156	2,141	185	60	393	- -	11,248
Wildlife Area Development	Acres		808	533	15	1	70	1,169	1,786	1,786	1,247	124	121	169	10	16,538
District Cooperators	No.		2,113	1,576	3,164	1,308	2,010	1,586	3,200	3,200	1,298	2,795	1,300	2,061	371	28,509

1954), from the State Soil Conservation Committee, created by the 1937 Session of the General Assembly of North Carolina. There are approximately 83,500 acres in the watershed, 53,500 acres in Stokes County and the remainder in Forsyth County. Town Fork Creek has its source in Hanging Rock State Park near Danbury, the county seat of Stokes County, and joins the Dan River about four miles east of Walnut Cove, Stokes County. The watershed is situated in the upper Piedmont section of North Carolina, and is partly in the Foothill sections near the Sauratown Mountain Range. The slopes are generally steep, and there is very little, gently-rolling land on the ridges. The gradient of the streams is steep and progressively gets steeper going upstream.

There are about 650 farms in the watershed, with an average site of approximately 125 acres. The watershed area is composed of about 52 percent woodland, 40 percent in cultivation and 8 percent in pasture. Most of the cropland is planted to row crops.

Watershed problems include erosion, sediment damage, swamping, flood damage, drainage, and major adjustments in the upper portions of the watershed required to keep the present acreage of row crops and obtain proper soil and water conservation. Treatment needed includes terracing, contour strip cropping, sod waterway development, sloping of banks, installation of check dams, tree planting, floodwater retarding structures, removal of obstructions, dredging, stream bank stabilization, and drainage.

A field examination of the Town Fork Creek Watershed was conducted by the State Conservationist in March 1955, and a recommendation for Federal assistance under the provisions of Public Law 566 is under consideration by the Director of the Soil Conservation Service, U. S. Department of Agriculture. It is estimated that 8 to 10 years will be needed to complete the project.

CHAPTER XI - LOWER ROANOKE RIVER PROBLEMS

Early History of the Problems - Interest of the United States Government in the striped bass fishery resources of Roanoke River dates back to 1884, when a Federal fish hatchery was established at Weldon to produce striped bass fry (young fish) for release in selected North Carolina waters. Since that date, continued interest and concern for the welfare of this fishery resource have been demonstrated on many occasions.

In 1946, the U. S. Fish and Wildlife Service studied the striped bass fishery of Roanoke River in relation to the probable effects of the John H. Kerr Reservoir Project. The Service's River Basin report, released in that year, recommended to the Corps of Engineers, U. S. Army, certain modifications in project construction and operation, cooperatively arrived at with the State of North Carolina, to alleviate possible adverse effects of this project. Subsequently, and for similar purpose, the Fish and Wildlife Service recommended to the Federal Power Commission stipulations regarding design of the Roanoke Rapids and Gaston projects.

During the three years prior to August 1954, the Service participated in cooperative studies and numerous conferences with interested State and Federal agencies to determine the minimimum flows and stages necessary to insure preservation of the striped bass fishery at Weldon and over-all preservation of the striped bass fishery resources in North Carolina. Due to a diversity of factors not originally foreseen, especially the marked increase in pollution load of Roanoke River resulting from introduced paper-mill wastes, the task of developing specifications for river flows at Weldon, that will insure preservation of striped bass fishery resources and still be equitable to all other interests, has proved infinitely complicated. From a fishery-preservation standpoint, the problem has two phases: (1) flows required to permit successful striped bass reproduction and insure preservation of the fishery resource, and (2) flows essential to provide good conditions for sport and commercial striped bass-fishing in the Weldon reach of the river during the annual spring spawning run of the species.

Field toxicity tests were conducted by the U. S. Public Health Service during the summer of 1953 with several industrial wastes discharged from the Halifax Paper Company. Wastes in descending order of toxicity to 27-mm bluegill sunfish are turpentine condensate, black liquor evaporator condensate at high hydrogen-ion concentration (pH), wash liquor, and black liquor evaporator condensate at low pH. In terms of the volumes of wastes discharged at the mill, wash liquor is the most important source of the toxicants, and black liquor evaporator condensate is second in importance.

Field toxicity tests indicated that (a) the polluted river water may be toxic, at least to small bluegill sunfish, at low summertime flows; (b) the toxicants must be considered in the design of treatment facilities for pulp-mill wastes; and (c) the average dissolved oxygen minimum, observed during the critical temperature period of 1953, was apparently adequate to sustain the resident fishes. Oxygen profiles, over the Weldon to Plymouth reach of the Roanoke River during mid-March, 1954, revealed no evidence of critical dissolved oxygen concentrations during the anadromous run of adult striped bass.

Meeting at Weldon on April 1, 1954 - The District Engineer, Norfolk District, Corps of Engineers, called a meeting to be held in Weldon on April 1, 1954 for the purpose of discussing, with representatives of interested State and Federal agencies, the future program for controlling river levels. His letter was mistaken as a call for a public hearing, which was held during the morning

and was followed by discussions by State and Federal agencies during the afternoon. Information regarding the discussions is not available.

At the public hearing, a representative of the State Stream Sanitation Committee stated that a preliminary pollution study of the Lower Roanoke River was complete except for toxicity tests which the Committee hoped to make during the spring of 1954, and that the Committee could not, however, hold public hearings on proposed classifications of streams in the Roanoke River Basin until probably some time during 1955. The District Engineer, emphasizing that the pollution problem represents a State responsibility, indicated that he would be guided, in operating the John H. Kerr Project during the 1954 spawning season, by recommendations of the North Carolina Wildlife Resources Commission and the State Stream Sanitation Committee. A representative of the Halifax Fishing Club presented a petition, signed by approximately 3,300 persons, calling for immediate and appropriate action toward abatement of pollution in the Roanoke River. A representative of the State Stream Sanitation Committee stated that Halifax Paper Company recognized its problem and has employed technical experts to study the situation and determine what could be done, that the committee needed determination of the toxicity of the stream in relation to the volume of flow, and that, from such determination, the committee would calculate the degree of treatment and amount of pollution which must be removed by the polluters, including the Towns of Roanoke Rapids, Weldon, Halifax, Williamston, and Plymouth, Halifax Paper Company, North Carolina Pulp Company, several textile plants, and other industries.

Conference at the Kerr Powerhouse on July 15, 1954 - Representatives of the State Board of Health, the State Stream Sanitation Committee, the Wildlife Resources Commission, the U. S. Fish and Wildlife Service, the U. S. Public Health Service, and the Corps of Engineers, U. S. Army, attended this conference. Statements made by the representatives are summarized as follows:

State Stream Sanitation Committee - Future raw water supply should be taken from near the surface and just upstream from the Roanoke Rapids Dam in order to avoid the costs of pumping equipment, pumping maintenance and operation, and possible additional treatment, and also to make public supplies more dependable. Water take-off from the proposed Gaston Dam should not be near the bottom in order to avoid poor quality in the Roanoke Rapids Lake. Future classification of this segment of Roanoke River must require a raw water quality adequate to meet the requirements for a public water supply utilizing the conventional treatment processes such as coagulation, sedimentation, filtration, and disinfection. The annual striped bass run is important. It has been damaged by increased pollution resulting from increased domestic sewage and industrial waste, and by the regulation of river flows, especially the low week-end flows. There is need for treatment of domestic sewage and industrial wastes discharged into the river without treatment, and for increased river flows. The damage to the fry is believed to be due to the toxicity of the wastes, particularly sulfides, mercaptans, and crude soap and related compounds. Extra water should be discharged during the striped bass season until the pollution abatement program can get underway and its effects can be studied and evaluated.

Wildlife Resources Commission - Male fish were extremely scarce during the 1954 run. On those occasions when the water stages at Weldon were 12 feet and 11 feet, there was practically no successful reproduction. The beginning of successful reproduction was observed when water levels of 13 feet were maintained at Weldon.

U. S. Fish and Wildlife Service - Augmented river flows alone will not

provide an equitable permanent solution to problems involved in preservation of the Roanoke River striped bass fishery. Industrial pollutants discharged into Roanoke River in the Roanoke Rapids reach must be reduced. As a temporary expedient until pollution can be controlled, supplemental releases of water constitute sound uses of water resources even though they involve appreciable power losses. As a result of observations during the 1954 striped bass run, the Service concludes that minimum stages of 13 feet at Weldon provide more desirable conditions for sport fishing because they provide better access to preferred waters above Highway 301 bridge at Weldon which are closed to commercial fishing. Access to these preferred waters by skilled rivermen is still possible at the 12 foot stage but not at lower stages. Conditions for commercial fishing at minimum stages of 13 feet are better than at lower stages although adequate for successful harvest at stages of 12 feet and 11 feet. It is essential that the design and plan of operation for Gaston Project consider fishery requirements with particular reference to dissolved oxygen, temperature, and river stages at Weldon. The dam and powerhouse should be constructed to allow discharge of waters from upper reservoir strata which will provide sufficient flow of high temperature water with adequate oxygen content to sustain striped bass spawn and permit survival of eggs and fry.

U. S. Public Health Service - No evidence of toxicity to adult striped bass was observed at any time during the 1954 season. The migrating adult fish prefer the greater quantity of water in the relatively pollution-free north channel for spawning. Selection of this channel may have protected the striped bass fishery from the full impact of pollution up to the present time. There is no satisfactory method for determining toxicities with striped bass eggs as the test organisms. No satisfactory technique has yet been developed for determining toxicities to small fish fry. The evidence obtained from the jar tests during the 1954 season, however, does indicate within a reasonable degree of certainty that the polluted waters of the Roanoke River at Weldon are toxic to striped bass fry under certain flow conditions. Adequate waste treatment, in combination with river discharges considerably above those suggested in earlier studies, will be necessary to restore full use of the Roanoke River to the striped bass. Gaston Dam, if constructed, will completely alter the water supply picture. The Gaston Project would inundate the 31 miles of open stream bed between Kerr Dam and the Roanoke Rapids Reservoir. If the turbine intake structures of Gaston Dam are located below the zone of stagnation during the summer months, the cold, deoxygenated effluent from Kerr Dam will probably flow as a thermal density current of virtually unchanged or diminished water quality through both the Gaston and Roanoke Rapids reservoirs. Deoxygenated water released from Roanoke Rapids Dam would have no value as a diluent for the oxygen-consuming industrial and domestic wastes discharged to the river in the Roanoke Rapids-Weldon area. Septic conditions could be expected in the Roanoke River below Weldon during most of the summer, even if exceptionally high degree of waste treatment is provided. Dissolved iron and manganese concentrations far exceeding Public Health Service standards can be expected of the deoxygenated water of the Roanoke Rapids tailrace. Excessive iron and manganese concentration in the public water supplies will require remodeling and additions to the water treatment plant and create very serious operational and control problems for textile production and bleaching of pulp.

Corps of Engineers - During the 1954 spawning run, the water released from Kerr in excess of that necessary to meet 1953 requirements could have been used to produce 28.7 million kilowatt-hours of electricity. Actually, a portion of this release was used to generate 14.8 million kilowatt-hours, sold at dump rate (3 mills per KWH), and the remainder, potentially 13.9 million KWH, was spilled. All of the additional water, used during the 1954 spawning season for

flow regulation, could have been used to generate dump energy and sold in accordance with terms of the existent contract.

The Corps is not authorized to operate Kerr Reservoir to prevent deterioration of the fishery which may be brought about by progressively greater pollution of the Roanoke River, since, under existing policies and laws, the abatement of pollution is the responsibility of the State. Therefore, it is incumbent upon the State that a permanent solution of the pollution problem, other than increased releases from Kerr Dam, be found. In 1954, the increased flows could be provided as a stop-gap measure and at a moderate loss of power revenue because one-third of Kerr power had not been contracted for. In 1955, it is expected that all of Kerr power will have been contracted for. In view of the substantial losses in power value that would result from continued operation of the project to provide increased minimum flows beyond that originally contemplated, the Corps most likely will not be in a position to provide the additional releases next year.

Action by conferees at Kerr Powerhouse on July 15, 1954 - It was agreed that attendance at future meetings, by representatives of other government agencies and private interests concerned in problems related to stream flow and pollution of the lower Roanoke River, would be necessary to arrive at a solution of the problems. It was further agreed that the State Stream Sanitation Committee would arrange for the next meeting to be held at Raleigh on September 2, 1954.

Meeting at Raleigh on September 2, 1954 - In addition to the agencies represented at the conference at Kerr Reservoir on July 15, the following agencies and private interests were represented at the meeting on September 2: Federal Power Commission, State Board of Health, North Carolina Department of Conservation and Development, National Council for Stream Improvement, Halifax Paper Company, North Carolina Pulp Company, Virginia Electric and Power Company, Roanoke Rapids Sanitary District, and Halifax County Health Department. Representatives of all of the agencies and private interests indicated above participated in discussions of lower Roanoke River problems during morning and afternoon sessions. A representative of the State Stream Sanitation Committee concluded the meeting by making substantially the following statements:

The Committee wants to be fair in all of their actions; they want advice, cooperation, and interest of all concerned agencies; and they need additional information in order to obtain a solution of the problems. A future conference will be held to obtain answers to questions regarding toxicants. The National Council for Stream Improvement has offered assistance. The Federal Power Commission will consult with Virginia Electric and Power Company and work out suitable ground rules for flow regulations. If satisfactory results from this consultation are not obtained, review by the Federal Power Commission will be requested. By working together, we can find a reasonable solution of the problems without too great impact on individuals or industries. In order to avoid errors, the Committee will not take hasty steps. The Committee must assign classifications to waters of Roanoke River Basin in North Carolina, and develop a plan for reconciling uses, within a reasonable period of time.

Meeting at Raleigh on October 27, 1954 - This meeting was attended by substantially the same representatives as those present at the meeting on September 2. The purpose of the meeting was (1) to discuss the water requirements on the Roanoke River and make recommendations to the Corps of Engineers concerning the minimum flows required during the 1955 striped bass season, and (2) to discuss the data collected to date on the water quality of the Roanoke River and make plans for further studies. No action was taken at the meeting by the con-

ferees as a result of these discussions.

Conference at Raleigh on December 13, 1954 - This conference was attended by representatives of the State Stream Sanitation Committee, the North Carolina Wildlife Resources Commission, the North Carolina Department of Conservation and Development, the University of North Carolina Institute of Fisheries Research, the U. S. Public Health Service, and the U. S. Fish and Wildlife Service. The group carefully considered the flow requirements at Weldon necessary for the preservation of the striped bass fishery during the 1955 season and unanimously adopted a resolution approving and recommending a schedule of minimum flows in the lower Roanoke River during the 1955 striped bass spawning season. During the conference, the agencies directly concerned with the striped bass fishery estimated its annual value to citizens of the State of North Carolina to be in excess of one and one-quarter million dollars, and determined that, to this figure, there should be added an indeterminate value, measured in terms of improved health derived from the recreation and diversion afforded by the fishery which is enjoyed by thousands of people who participate in the annual fishing activities along the lower Roanoke River. It was the consensus of the group that the annual value of the fishery to the people of the State far exceeds the value of any power that may be lost due to providing the augmented flows from the storage pool at the John H. Kerr Reservoir.

In accordance with the determinations reached at this conference, the Wildlife Resources Commission prepared a letter, dated December 13, 1954, to the District Engineer, Norfolk District, Corps of Engineers, recommending minimum requirements necessary, during the 1955 striped bass spawning season, to permit the adult fish to reach their spawning grounds and to provide for the successful survival and development of the eggs and fry, and the State Stream Sanitation Committee dispatched a letter, dated December 15, 1954, to the District Engineer, Norfolk District, Corps of Engineers, recommending flow releases at the John H. Kerr Dam adequate to provide minimum flows, as measured at the highway bridge at Weldon, during the remainder of 1955 not covered in the letter of the Wildlife Resources Commission, attached to the Committee's letter. The Committee indicated their action toward classification of waters in the Roanoke River Basin, following which the State will have the authority for, and will expect to proceed with, an effective pollution abatement program. It was stated that, in the interim period, it will obviously be necessary to depend upon augmented flows to maintain water quality suitable for downstream uses. There were also attached, to the Committee's letter, copies of letters from North Carolina Pulp Company and Halifax Paper Company, indicating the interest of these industrial concerns in the pollution problem and confirming the fact that efforts are being made to define their problems and to develop an economical and realistic approach to pollution-abatement measures. The Committee offered their recommendations and those of the Wildlife Resources Commission regarding 1955 flow releases in the interest of preserving the striped bass fishery as well as for protecting the other uses on the Roanoke River.

Conference in office of the Secretary of the Interior, March 24, 1955 - This conference was arranged by Representative Herbert C. Bonner, First N. C. Congressional District, for the purpose of obtaining the 1955 flow releases indicated immediately above, and was attended by Representatives L. H. Fountain and Graham A. Barden, Second and Third N. C. Congressional Districts, respectively, and Senator W. Lunsford Crew, representing Halifax County in the Senate of the General Assembly of North Carolina, in addition to representatives of the North Carolina Wildlife Resources Commission, the North Carolina Department of Conservation and Development, the Southeastern Power Administration, the U. S. Fish and Wildlife Service, and the Corps of Engineers, U. S. Army.

Representative Bonner presented a compromise proposal for 1955 flow release from Kerr Dam for consideration in lieu of those recommended by the Wildlife Resources Commission, and called on interested North Carolina persons to make statements to the Under Secretary of the Interior, who presided at the conference.

Representative Fountain indicated the damages to sport fishery and increase in the stream pollution which would result from the low flows proposed by the Corps of Engineers, Representative Barden set forth the losses that would be incurred by the people of Eastern North Carolina, particularly the commercial fishermen, if striped bass spawning in the vicinity of Roanoke Rapids is eliminated or greatly reduced. State Senator Crew and representatives of the Wildlife Resources Commission and the Department of Conservation and Development made statements supporting the views of Representatives Fountain and Barden.

The Under Secretary of the Interior, after presentations by representatives of the U. S. Fish and Wildlife Service, the Southeastern Power Administration, and the Corps of Engineers, made substantially the following statements in summing up the presentations.

We all have to take an over-all look at the deep-seated conflicts and potentialities involved in these problems. We do not want to destroy the fishing industry. The Department of the Interior problems in the release of water from the John H. Kerr Reservoir are as follows:

a. If the dam had not been built, the difficulities would have been the same inoccasional years of low flow.

b. Establishment of minimum flows corresponding to requested levels at the Weldon gauging station are in competition with other purposes of the dam.

c. The Departments of the Army and the Interior are operators, the Army to supply the power, and the Interior to market the power.

d. Certain costs of construction of the dam were allocated to hydroelectric power, and these costs must be liquidated over a period of 50 years.

e. The Department of the Interior has contracts with electric cooperatives based on fixed amounts of power.

f. Water lost to striped bass survival will have to be recouped in sale of power.

g. We cannot do this indefinitely without repercussions from people demanding a low power rate.

h. Pollution will have to be solved at the State level, and more and more water will be required in the future to solve the abatement problem.

Representative Bonner reminded the Under Secretary that the Department of the Interior has dual responsibilities covering natural resources and the marketing of electric power, and that the situation under discussion constituted an emergency. The Under Secretary of the Interior stated that the compromise-proposal figures would be accepted. Representative Bonner expressed appreciation for the Under Secretary's cooperation and the satisfactory conclusion reached. The compromise-proposal figures comprised water-level positions lower than those recommended by the Wildlife Resources Commission and higher than those proposed by the Corps of Engineers.

Meeting at Raleigh on May 24, 1955 - This meeting was attended by representatives of The State Stream Sanitation Committee, North Carolina Wildlife Resources Commission, North Carolina Department of Conservation and Development, University of North Carolina Institute of Fisheries Research, U. S. Fish and Wildlife Service, U. S. Public Health Service, and Corps of Engineers, U. S. Army. The purpose of the meeting was to organize a Steering Committee for Roanoke River Studies in accordance with agreement reached at a meeting earlier in the mouth in Weldon, at which Representative Herbert C. Bonner presided. The objective of the further studies of lower Roanoke River problems is to effect a long-range solution of the problems in lieu of annual solutions as reached in the spring of 1954 and the spring of 1955.

Studies made in 1953 and 1954 were briefed, and additional waste treatment processes, which the Halifax Paper Company is placing in operation and plans to place in operation in the immediate future, were outlined. A "Suggested Study Program - Roanoke River Problems" and "Proposed Studies on the Roanoke River with reference to Water Quality and the Affected Fish Population" were discussed. Tentative agreement, on responsible agencies to effect water quality studies, determinations of survival of striped bass eggs and fry, establishment of desirable flow patterns, and determination of status of the fishery, was reached. Dr. Willis King, Regional Office, U. S. Fish and Wildlife Service, Atlanta, Georgia, was unanimously elected as Chairman of the Steering Committee.

The Committee reached agreements as follows:

(1) Preparation by the Executive Secretary, State Stream Sanitation Committee, of a letter from the Chairman to the Federal Power Commission, indicating recommended flow-patterns for the calendar years 1956-1959, inclusive, with copies to Representative Bonner, concerned agencies, and the Governor of North Carolina, with request that the Governor transmit a letter to the Federal Power Commission, supporting the recommendations;

(2) Invitations to Virginia Electric and Power Company and the National Council for Stream Improvement to establish representation on the Committee;

(3) Holding of next meeting of the Committee on or about July 7;

(4) Establishment of task forces of the Committee as follows:

Task Force I - Water Quality and Engineering
Task Force II - Biological Studies and Flow Recommendations
Task Force III - Status of the Fishery; and

(5) Holding of meetings of the three task forces in time to present their recommended programs at the meeting of the Committee on July 7.

Meeting of the Steering Committee for Roanoke River Studies at Raleigh on July 7, 1955 - Plans of the three task forces were presented to the Committee and were approved. A proposed letter from the State Stream Sanitation Committee to the Governor of North Carolina, and proposed letters from the Governor to the Federal Power Commission, the District Engineer, Norfolk District, Corps of Engineers, and their enclosures, "Recommended Schedule of Minimum Flow Requirements in Roanoke River at Weldon, North Carolina," to be in effect during the progress of the studies of the Steering Committee, were also approved by the Committee. It was agreed that the next meeting of the Committee would be held at the call of the Chairman.

Meeting of the Steering Committee for Roanoke River Studies at Raleigh on November 29, 1955 - Composition of the Steering Committee, its Subcommittee for Operations, its Field Representative, and its Task Forces was approved as follows:

Membership of the Committee - One representative each of the following agencies and interests:

State Agencies
- State Stream Sanitation Committee
- North Carolina Wildlife Resources Commission
- North Carolina Department of Conservation and Development

Federal Agencies
- Southeastern Power Administration
- U. S. Fish and Wildlife Service
- U. S. Public Health Service
- Corps of Engineers, U. S. Army

Industry
- Virginia Electric and Power Company
- Halifax Paper Company
- North Carolina Pulp Company
- National Council for Stream Improvement

At Large
- Sport Fishermen
- Commercial Fishermen
- Citizens

Membership of Subcommittee for Operations

Director, Robert A. Taft Sanitary Engineering Center, U. S. Public Health Service, Chairman of the Subcommittee

Chairman of the Committee for Roanoke River Studies and Vice-Chairman of the Subcommittee

Executive Secretary, State Stream Sanitation Committee, Chairman of Task Force No. 1, and Secretary of the Subcommittee

Chief, Fish Division, North Carolina Wildlife Resources Commission, and Chairman of Task Force No. 2

Chief Engineer, Division of Water Resources, Inlets and Coastal Waterways, North Carolina Department of Conservation and Development, and Chairman of Task Force No. 3

Field Representative - Dr. Frederic F. Fish, Biologist, Regional Office, U. S. Public Health Service, Atlanta, Georgia

Task Force No. 1
- State Stream Sanitation Committee, Chairman Agency
- U. S. Public Health Service
- National Council for Stream Improvement
- U. S. Fish and Wildlife Service
- Corps of Engineers

Task Force No. 2

North Carolina Wildlife Resources Commission, Chairman Agency
U. S. Fish and Wildlife Service
U. S. Public Health Service
National Council for Stream Improvement

Task Force No. 3

North Carolina Department of Conservation and Development, Chairman Agency
North Carolina Wildlife Resources Commission
U. S. Fish and Wildlife Service
University of North Carolina Institute of Fisheries Research
National Council for Stream Improvement
(contract with North Carolina State College).

Responsibilities were approved by the Steering Committee as follows:

Steering Committee - Establishment of general policies and all major decisions involving policy in the conduct of the Studies.

Subcommittee for Operations - Preparation of comprehensive program of study for review and approval by the Steering Committee, development of detailed plans for studies, advice to Task Forces relative to execution of studies, and major changes in the technical study plans.

Field Representative - Implementation of plans and decisions of the Subcommittee, maintenance of necessary liaison between the Subcommittee, Task Forces, and others in order to obtain the objectives of study, preparation of progress reports requested by the Subcommittee, and attendance at Steering Committee and Subcommittee meetings in an ex officio capacity.

Task Force No. 1 - Determination of quality, nature, and pattern of discharges of pulp mill wastes and municipal sewage, together with evaluation of the resultant effects upon water quality in the river; determination of the influences of impoundment and flow releases upon the physical and chemical qualities of the water, and, in turn, their influence upon suitability of the waters as a waste diluent and vehicle; and recommendations of flows required to prevent deterioration of water quality.

Task Force No. 2 - Conduct of studies on striped bass, having emphasis upon the reproductive phase of the life cycle in the Roanoke River; determination of the survival of eggs and fry under existing conditions; evaluation of other species as indicator fish suitable for experimental use at other seasons; and provision of technical data to show the quality and quantity of water necessary to protect the striped bass fishery.

Task Force No. 3 - Location of spawning areas; determination of survival, following growth, and migrations; hydrographic and productivity studies; assessment of populations and impact of fish harvest upon them; indication of relative effect of various limiting factors; and recommendations for fishing regulations and habitat improvements needed to conserve the fishery.

Reports of progress since the meeting of the Steering Committee on July 7, 1955, were made by Task Force Chairmen as follows:

Task Force No. 1 - Studies of wastes from Halifax Paper Company's plant show that, since the 1953 survey, B.O.D. from the plant had decreased by 44% while, during the period of the study, pulp production had increased by 13% and paper pro-

duction had increased by 16%. Resin acid soaps were not detectable in the paper mill effluents and were detectable only in low concentrations in the pulp mill effluents. Samples collected at Highway No. 48 bridge indicated an average dissolved oxygen concentration of 5.7 ppm at 24°C. The similar concentration was 8.1 ppm in 1953. The capacity of the river to assimilate wastes is now 24.3 pounds of 5-day 20°C. B.O.D. per cfs, as compared with 36.18 pounds in 1953. Kerr Reservoir sampling on September 14, 1953 revealed no appreciable stratification in the reservoir. Iron and magnesium were found in high concentrations at a depth of 80 feet in Kerr Reservoir. Samples collected from Roanoke Rapids Reservoir on September 15, 1955 indicated no significant difference in either temperature or dissolved oxygen for samples collected from near the surface to the bottom of the reservoir. Iron was found to vary from 2.0 ppm near the bottom to 1.3 ppm 15 feet below the surface. Only a trace of manganese was found at any depth other than the bottom sample.

Task Force No. 2 - Field activities have been limited by an absence of funds. The Wildlife Resources Commission has agreed to provide the services of one biologist full time to assist the Field Representative in carrying out studies on striped bass reproduction and survival in the Weldon area, in addition to services of the regular staff of Task Force No. 2 Chairman on a part-time basis. Engineering sketches of experimental ponds, to determine survival of striped bass under varying river conditions and located preferably on property of Halifax Paper Company, will be submitted to the Company for review and decision. (Since the meeting on November 29, the U. S. Fish and Wildlife Service has allotted $7,000 to the work of Task Force No. 2 during Fiscal Year 1956).

Task Force No. 3 - A grant of $32,000 from Saltonstall-Kennedy funds was recently made available. The personnel of the task force consists of a project leader and a biological investigator, assisted by the staff of U.N.C. Institute of Fisheries Research. Two more biological investigators are geing sought for the project. A hydrographer has been added to the Institute staff, and a finfish investigator will be added within two months.

Fish dealers and fishermen in the Albemarle Sound region have been contacted personally in connection with collection of catch-effort statistics, and good public relations have been established. Four hundred striped bass have been tagged.. One return had been made to date of meeting. Results of search of Perquimans River and certain areas of Albemarle Sound westward of the mouth of Perquimans River, for young-of-the-year by means of seine and gill nets, thus far are negative. Seventy specimens were taken for racial, food, and sex dimorphism studies. A 43 ft. balloon trawl is being used in Albemarle Sound as a fish-collecting device. Hydrographic stations have been set up in Albemarle Sound, and monthly cruises will be made. North Carolina State College personnel, under a contract with the National Council for Stream Improvement, are making studies of fry escapement and growth of young bass in Roanoke River and western Albemarle Sound. Patrol vessels and personnel of the Division of Commercial Fisheries, North Carolina Department of Conservation and Development, were made available at Edenton and Manteo to assist the U.N.C. Institute of Fisheries Research personnel in their investigations.

The Steering Committee approved the detailed plans, presented by the three Task Force Chairmen, for future activities pertaining to Lower Roanoke River Studies.

Meeting of the Subcommittee for Operations at Raleigh on November 30, 1955 - The Subcommittee approved, for recommendation to the Steering Committee for appropriate action, the following types of reports considered necessary to

record the work of all participants in the Roanoke River Studies. These reports will, in general, be developed as follows:

a. Progress Reports - Each Task Force Chairman shall be responsible for the preparation of reports at regular intervals which shall reflect the activities and accomplishments of his group since the date of his last progress report.

b. Job Completion Reports - Upon the completion of any particular segment of the studies, the Chairman of the responsible Task Force, the Field Representative, or the Project Leader, as appropriate, shall prepare a Job Completion Report covering the work completed. Such reports shall be presented through the Subcommittee for Operations to the Steering Committee for appropriate action.

c. The Comprehensive Report - A Comprehensive Report shall be prepared at the conclusion of the studies by the Field Representative assisted by the various Task Forces. This report will consist of the total findings of all Task Forces, and shall include conclusions and recommendations for establishing and carrying out a comprehensive plan for adequately protecting the water requirements of the Lower Roanoke River suitable for present and foreseeable needs. Such report shall be presented through the Subcommittee for Operations to the Steering Committee for appropriate action. It is anticipated that the studies will be completed and the final report issued on or about June 30, 1959.

Meetings of the Subcommittee for Operations at Raleigh on January 10 and 11, 1956 - The Chairman of the Steering Committee referred to his letter of December 2, 1955 to the Southeastern Power Administration, requesting that the needs of the striped bass fishery and the necessity for maintaining acceptable water-quality standards be considered in any modification of river flows, including establishment of both peak discharges and minimum flows, in considering the disposal of the remaining potential power at Kerr Dam through a contract with the Carolina Power and Light Company. He also referred to the Administrator's reply, stating (1) that the Administration cannot consent to a guarantee, for 1956 or for any year in the future, that water, in addition to normal power releases, will be made available for the 3-day fish-attraction flow (normally occurring March 23 to March 25, inclusive, and providing the necessary depth and temperature to induce the striped bass to make the journey from the mouth of the Roanoke River to the spawning grounds near Weldon), and (2) that the Administration can agree to certain changes in the rules of operation of the Kerr Project which will increase the probability that water will be available to maintain the stages desired.

The Chairman of the Steering Committee summarized occurrences at a meeting in the office of the Secretary of the Interior on December 30, 1955, held for the purpose of discussing Lower Roanoke River problems and attended by representatives of the U. S. Fish and Wildlife Service, Federal Power Commission, Southeastern Power Administration, U. S. Public Health Service, and Corps of Engineers, U. S. Army. A proposal to modify the rule curve for operation of the John H. Kerr Project was made by a representative of the Southeastern Power Administration. The Assistant Secretary of the Interior concluded the meeting with a statement that a second conference probably will be necessary prior to the 1956 striped-bass-spawning season, in order to reach a settlement of the issues involved.

A representative of the Corps of Engineers conducted a discussion of the annual operations of the John H. Kerr Project during the period from about January 1 to about May 17 under the provisions of the rules for operation of the project. The Administrator for the Southeastern Power Administration presented a tabulation of flows, available in the interests of striped bass propagation, for each of the seven weeks from April 2 to May 20, inclusive, during each of the years from 1912 to 1955, inclusive.

The Subcommittee for Operations, as a result of discussion with representatives of the Southeastern Power Administration and the Corps of Engineers, established the following facts:

a. The rule curve for operation of Kerr Reservoir may be altered without loss in a power revenue so as to provide additional flows for the benefit of the fishery, thereby partially satisfying the Steering Committee's recommendations.

b. The remaining flows required to meet the recommendations of the Committee so as to meet the needs of the fishery can be provided by other reasonable changes in the operational program for Kerr Reservoir.

c. Except in periods during which high flows are needed for fishery benefits, Kerr Reservoir will normally discharge water at approximately three times the rate necessary to provide the minimum flows required in the production of power to meet contractual agreements.

d. Inasmuch as stream flows in the Roanoke River below Kerr Reservoir are re-regulated by the Virginia Electric and Power Company at their Roanoke Rapids Dam, it is necessary that the operation be integrated with the releases from Kerr Dam in such manner as to assure the downstream stages recommended by the Steering Committee.

e. The minimum flows recommended were predicated upon at least 90 per cent of saturation with dissolved oxygen in the tailrace of Roanoke Rapids Reservoir, a condition which prevailed prior to the construction of this project. The oxygen content has been reduced materially by deoxygenation within the impoundment. This diminution in the oxygen supply must be offset by effective remedial measures. Degradation of water quality must receive serious consideration in connection with further impoundment of the Lower Roanoke River.

The Subcommittee reaffirmed the flow recommendations adopted by the Steering Committee on July 7, 1955, and adopted the following recommendations:

a. That proper steps be taken to minimize deviation from the recommended schedule.

b. That, during the interim period of the studies, temporary measures be taken in order to provide the flows recommended by the Steering Committee.

c. That action be taken to accomplish the recommendations in the Joint Resolution of the 1955 Session of the General Assembly of North Carolina pertaining to flows required to meet the needs of the striped bass fishery and the necessity for maintaining acceptable water-quality standards.

<u>Action by the State on flow recommendations adopted by the Steering Committee</u> - The Governor, on April 3, 1956, advised the Assistant Chief of Engineers for Civil Works, Department of the Army, that the recommended flows as contained

in the "Recommended Schedule of Minimum Flow Requirements in Roanoke River at Weldon, North Carolina", adopted by The Steering Committee for Roanoke River Studies on July 7, 1955, will be essential to the best interest of the people of North Carolina.

Meeting of the Steering Committee at Weldon on May 23, 1956 - The Committee heard reports of progress of its three task forces, and of work of its Subcommittee for Operations, subsequent to its meeting on November 29, 1955, and statements regarding flows provided during the season. Some of the statements regarding the relative success of the season follow.

The run of the striped bass this year was fewer than in 1955, and still less than in 1953. The fish had better chances of spawning this year than in previous years. Fifteen feet stages provided good runs of fish during the last few days of the season. It was a very poor year from the standpoint of sport fishermen. The great majority of people here had a poor season. We feel that this group is accomplishing its objectives. We need industry in this area. Eggs were abundant. Fish were not abundant. Fish kills occurred at Palmyra, Hamilton, The Gut, and Williamston.

A representative of Virginia Electric and Power Company read a proposal of minimum discharges from its Roanoke Rapids Reservoir as a basis for licensing the Gaston Project. A representative of Halifax Paper Company made a statement regarding the proposal, opposing its acceptance and indicating a considerable number of reasons for such opposition. The Chairman, pursuant to a motion of the Committee, appointed a Special Committee on Water Economics to submit recommendations concerning matters pertaining to generation of hydroelectric power by use of water in the Lower Roanoke River.

Meeting of the Subcommittee for Operations at Weldon on May 24, 1956 - The Subcommittee, after about four hours of discussion of the Vepco proposal, passed a motion that the Special Committee on Water Economics present views and comments on the Vepco proposal to the Subcommittee for Operations for consideration and recommendations to the Steering Committee for appropriate action. The Subcommittee discussed matters pertaining to activities of the Task Forces during the remainder of the calendar year 1956.

Action by the State regarding future flows in the Lower Roanoke River - The Governor, on May 30, 1956, advised Congressman L. H. Fountain that the John H. Kerr Reservoir should be operated in such manner as to provide the July 7, 1955 recommendations of the Steering Committee until such time as the Roanoke River Studies have been completed and a new schedule of minimum releases has been established on a permanent basis for all projects regulating stream flows. The Governor expressed his thought that Congress should authorize the Department of the Interior, the Corps of Engineers, U. S. Army, and other appropriate Federal agencies to take whatever action they consider necessary to establish a new schedule of minimum releases, in order to take care of downstream requirements of various users in accordance with the best knowledge that has been obtained to date, and that, upon completion of studies in progress and upon final conclusion as to what recommendations for downstream requirements should be made, Congress could then enact legislation setting up definite permanent schedules.

The Governor, on June 7, 1956, advised Congressman L. H. Fountain of his thought, in addition to that contained in his letter of May 30, that it would be advisable that Congress authorize the Chief of Engineers, Department of the Army, to re-evaluate the benefits of the John H. Kerr Project and to include in the re-evaluation an evaluation of the presently unevaluated benefits. The Governor

expressed his belief that such re-evaluation would possibly change the annual amortization of the project assigned to power, so as to enable the Corps of Engineers and the Southeastern Power Administration to operate the John H. Kerr Reservoir in such a manner as to provide more adequately flows in the Lower Roanoke River required for supply of water for industries, municipalities, and agriculturists, abatement of stream pollution, and conservation of the striped bass fishery.

Congressman L. H. Fountain advised the Governor, on June 19, 1956, that the Public Works Committee, House of Representatives, had adopted a resolution authorizing the Corps of Engineers to review the prior reports on the Roanoke River and to submit to Congress at the earliest practicable date recommendations for any modification of project plans that may be advisable concerning existing and foreseeable needs for flood control and power production with particular attention to flow regulation,pollution abatement, navigation, and fish preservation.

Meeting of the Special Committee on Water Economics - The Special Committee, at the meeting on September 5, received and considered statements of representatives of the Corps of Engineers, Virginia Electric and Power Company, Wildlife Resources Commission, Halifax Paper Company, and Southeastern Power Administration regarding flows during the striped-bass-spawning season, and statements of representatives of Virginia Electric and Power Company, State Stream Sanitation Committee, and Halifax Paper Company regarding pollution-abatement flows during the remainder of the year, for use while Steering Committee studies are in progress. No conclusion regarding these flows was reached at the meeting.

The Special Committee, at a meeting on October 25, heard recommendations that the Field Representative, Roanoke River Studies, was willing to make to State fishery interests regarding flows during the striped-bass-spawning season and comments thereon by representatives of Virginia Power and Electric Company (hereinafter referred to as Vepco) and Southeastern Power Administration. No conclusion regarding these flows was reached at the meeting.

Meeting of the Subcommittee for Operations on November 27, 1956 - The Subcommittee heard reports on action regarding Vepco's proposal; considered a recommendation regarding the schedule of minimum flows during 1957; reviewed reports on experimental re-regulation of the Roanoke River, Task Force II operations during the 1956 striped-bass season, and 1956 investigations on the Roanoke Rapids Reservoir; approved an outline of the comprehensive report of the Steering Committee; and prepared a resolution regarding Vepco's proposal for consideration by the Steering Committee.

Meeting of the Steering Committee on November 28 - The Committee heard progress reports of its three task forces; received the report of the Subcommittee for Operations regarding Vepco's proposal and recommendations for schedule of minimum flows during 1957; received the report of the Special Committee on Water Economics; approved the outline for its comprehensive report; and adopted the proposed resolution of the Subcommittee for Operations. The resolution declared that consideration of Vepco's proposal was discontinued until more conclusive data becomes available and recommended that Vepco participate in a joint study to collect adequate data to serve as the basis of a new proposal which could be expected to result in downstream river conditions which would maintain satisfactory water quality.

Action by the State on Vepco's Proposal - The Governor received a letter from the President, Virginia Electric and Power Company, outlining the Vepco

proposal, stating that the counter-proposal of the State and Federal agencies concerned was unacceptable to Vepco, expressing fear that solution of the problem will continue to be delayed unless some vigorous effort on the part of the Governor is exerted, and urgently requesting the Governor's assistance in order that the present impasse may be broken. In his reply of December 17, 1956, the Governor stated that he saw no reason for the indicated fear and did not believe that an impasse had occurred. He expressed the opinion that, after reasonable consideration by Vepco of the enclosed report of the concerned agencies and participation by Vepco in the joint study recommended by the Steering Committee, means can be found to resolve the differences between Vepco and the Committee and to reach, in the not too distant future, a solution of the problems that will be equitable both to Vepco and the State.

CHAPTER XII--NAVIGATION AND FLOOD CONTROL

Navigation Project—The existing project provides for a channel 12 feet deep and 150 feet wide in Roanoke River from Albemarle Sound to Plymouth, thence 10 feet deep and 100 feet wide to Hamilton, thence 8 feet deep and 80 feet wide to Palmyra Landing and thence 5 feet deep and 50 feet wide to Weldon, a total distance of 131 miles.

The project was completed in 1941 to Palmyra Landing, 50 miles below Weldon, which is the practicable limit for providing improvement for navigation by channel improvement alone. The cost of the project was about $404,600.

The average annual water-borne traffic for the period 1949-1953 was about 376,400 tons, principally wood and petroleum products. Commerce in 1953 totaled about 403,600 tons.

House Document No. 65, Seventy-fourth Congress, First Session—This document contains the reports of the Chief of Engineers, U. S. Army, the Board of Engineers for Rivers and Harbors, the Division Engineer, North Atlantic Division, and the District Engineer, Norfolk District, covering navigation, flood control, power development, and irrigation in the Roanoke River Basin. The report of the Chief of Engineers concluded that, while affording a potential source of hydroelectric power, a comprehensive plan for the improvement of Roanoke River and its tributaries for navigation, and the prosecution of such improvement in conjunction with the development of potential power, flood control, or irrigation, was not economically justifiable at that time (1934). No mention was made in the report of the vulnerability to floods of the towns in the valley of the Smith River, a tributary of the Dan River which in turn flows into the Roanoke River.

Congressional Action—Following the disastrous flood in the lower Roanoke River Basin in August 1940, the Committee on Flood Control of the U. S. House of Representatives, on August 28, 1940, adopted a resolution, requesting the Board of Engineers for Rivers and Harbors to review the reports on the Roanoke River, Virginia and North Carolina, as contained in House Document No. 65, 74th Congress, 1st Session, with a view to determining whether any improvements in the interests of flood control and allied purposes were advisable at that time. The Committee on Rivers and Harbors, U. S. House of Representatives, also adopted a resolution on January 26, 1942, requesting the Board to review the reports as contained in House Document No. 65 with a view to determining whether any improvements were advisable at that time.

Situation in 1943—The report of the District Engineer, Norfolk District, dated January 30, 1943 and submitted in response to the resolutions indicated in the preceding paragraph, is contained in Document No. 650, 78th Congress, 2nd Session. The situation in the Roanoke River Basin at that time was as follows.

Storms—Flood-producing storms in the Roanoke River Basin had occurred in all seasons of the year. Winter storms, like those of January 1936 and January 1937, had produced frequent floods throughout the basin. In this type of storm, the rainfall is usually sustained but not intense. Summer and fall storms, like those of August 1939 and October 1937 had frequently caused extreme floods, usually in only parts of the basin. These latter types of storms are often associated with tropical hurricanes, and the rainfall is ordinarily brief but intense.

The infrequent winter storms of unusual intensity, like that of March 1912, or rare summer storms of a general nature, such as that of August 1940, were capable of producing floods of extreme size over large areas.

Flood Records—Continuous, or nearly continuous, records of daily river stages for 40 years or more were available for the Roanoke River Basin at Roanoke, Clarksville, Weldon, and Danville. Records of less length were available for numerous other points. The flood of August 1940 was the greatest of record in most of the basin. The flood of 1877 was the second largest in the lower reaches of the Roanoke River and the largest in the headwater region of the Roanoke and Dan Rivers. The 1940 flood reached a crest stage of 58.0 feet on the United States Weather Bureau gage at Weldon, compared to 54.3 feet for the flood of November 1877. During the period 1899 to 1940, 39 floods exceeded a stage of 40 feet on this gage, and 163 floods exceeded a stage of 31 feet. The flood of August 1940 was the largest on this stream below Martinsville, Virginia, since the flood of 1899.

Stream Flow Characteristics--The great width of the Roanoke River watershed in the steeper headwater area, and narrowness of the basin in the flatter and lower part of the Piedmont Plateau and the Coastal Plain, particularly in the section between Norlina in Warren County and Weldon in Halifax County, tended to produce floods which characteristically rose at Weldon in about 4 days and receded in about 3 days. Rapid initial rise and swift recession from the peak were indications that the floods were composed of numerous flashy floods from tributaries, following one behind the other, rather than of sluggish flows peaking one upon the other. Hyco River and its tributaries in Person and Caswell Counties, and Bannister and Falling Rivers in Virginia, had the least flashy floods of any gaged tributaries. These characteristics of the Roanoke River were also characteristics of the Dan River and upper Roanoke River, which contributed their peak discharges to the main stem of the stream at Clarksville at about the same time. The volume of floodwaters stored in the flood plain was large, so that the passage of the flood wave was slow. However, the rapid recession of flow released water from valley storage to add to the downstream peak flow. As a result of this swift recession, the flood peaks passed downstream without great diminution of peak discharge, usually affected by valley storage, and with very little change in shape of the hydrograph except that due to intermediate inflow. Most of the streams in the Roanoke River Basin flow easterly, while the majority of storms pass northerly across the watershed in a few hours. The natural tendency toward desynchronism of peak discharge in a long, narrow watershed was thus given maximum opportunity.

Storm of August 10-17, 1940--This storm, which swept most of the South Atlantic States, was the most widespread and intense great-rainfall producer of which there is any record in this watershed. Associated with a tropical hurricane, the storm was blocked in its northward passage, near the Virginia-North Carolina State line, and was diverted along the axis of the Roanoke River Basin in an easterly direction. The heaviest precipitation, 17.5 inches, occurred along the northeasterly edge and just outside of the basin, with a rainfall averaging 12.8 inches over 8,000 square miles around a center at Keysville, Virginia. The average depth of rainfall on the Roanoke River watershed above Roanoke Rapids (drainage area of 8,410 square miles) was 10.1 inches, most of which occurred in 2 days. Three stations in the basin, Copper Hill about 15 miles southwest of Roanoke, Clarksville, and Randolph about 20 miles northwest of Clarksville, recorded over 15 inches of rainfall. Prior to this storm, only one station in Virginia was known to have experienced more than 10 inches in a similar period of general rainfall. The August

1940 storm lacked the intensity required to produce record stages on steep, small tributaries. Because of the long duration of general rainfall, the flood volume was unusually large. At all points below Weldon, where volume as well as discharge influenced the stage, the unusual volume of run-off during this flood contributed to create stages not exceeded in 225 years of known continuous settlement.

CONDITIONS RESULTING FROM FLOODS

General—Frequent floods in the Roanoke River caused considerable loss and inconvenience to agricultural interests and urban areas, and to transportation and communication facilities. Although the damages occurred throughout the watershed, the major flood losses were confined mainly to the Roanoke, Dan, and Smith Rivers. The greatest portion of the agricultural area subject to flood damage, prior to construction of the Buggs Island Project, comprised the lower part of the Roanoke River Valley on the Coastal Plain in North Carolina. About 10 cities and towns in the Roanoke River Valley, 4 in the Dan River Valley, and 6 in the Smith River Valley, had, prior to 1943, experienced flood damages. Most of these municipalities are important marketing centers, and several contain large industrial establishments. The major portion of the damages resulting from large floods occurred in the lower part of the basin in North Carolina. The flood plain of this portion of the basin was from 1 to 6 miles wide and contained about 78 per cent of the total area, and 61 per cent of the agricultural area, on the flood plains of the three main rivers formerly subject to inundations from floods.

Flood-Protection Works Existing prior to 1943—Prior to 1877, several levees, constructed with slave labor, were maintained along both banks of the Roanoke River between Weldon and Williamston, During the great flood of that year, most of these levees were badly breached. However, two large levees were maintained until the disastrous flood of 1940. Both of these earth levees, one about 6 miles in length to protect farm land near Norfleet in the northeastern corner of Halifax County, and the other, 8 miles long, to protect the Caledonia State Farm near Halifax in the same county, were partly destroyed in August 1940. Early in January 1943, the former was being repaired by local interests, and the latter had been abandoned. Two small levees were constructed near Roanoke by private interests subsequent to the 1940 flood to protect industrial plants. Levees at South Boston and Danville also provided protection.

The August 1940 Flood— Three lives were lost during the flood, and thousands were made homeless. Large tracts of agricultural land, numerous industrial plants, and commercial establishments were flooded, and traffic and communication facilities were interrupted.

Urban Losses—Twenty-four cities and towns throughout the watershed sustained damages, varying from a few hundred dollars to almost a million dollars, as a result of the August 1940 flood. Five of these municipalities each sustained losses of a hundred thousand dollars or more.

Most of the damage was to industrial plants located in the flood plain. In some instances, a rise in stage of an additional foot or two would have greatly increased the damages. Industrial plants, which were flooded, were generally those on which the communities are dependent for their livelihood. About 19,000 persons, mostly employed therein, were directly affected. The time required to

return to normal production varied from a few days to about 2 months. The damages to domestic, municipal, and commercial properties were not large.

The water-supply systems of 10 of the cities and towns in the watershed were affected by the flood, and several were forced to suspend operation for as long as 7 days. At Weldon, it was necessary to obtain the services of a United States Army portable filtration unit, which rationed water for 6 days until the flood had subsided and the water-supply system was rehabilitated.

Agricultural Losses-- The flood plains in the Dan and Smith River Valleys are usually narrow and flanked by bluffs which become precipitous in the headwater reaches. Subsistence crops are raised on the flood plains and cash crops on the uplands. The damages from the August 1940 flood in these areas were not of major consequence, as the farm enterprise was mainly situated above the flood plain and was not dependent for its continuity on the crops raised on the bottom lands. With few exceptions, there were no buildings on the bottom lands and most of the farm machinery was stored on high ground.

Practically the entire crop on the flood plains in the Dan and Smith River Valleys was destroyed by the 1940 flood. A small amount of farm improvement was damaged, and several hundred head of cattle were drowned, between Clarksville and Weldon where cattle raising was extensively pursued.

Below Weldon, practically all of the farms in the valley were located on the wide flood plain and were completely inundated by the August 1940 flood. In this area, the flood not only affected the farm income but disrupted the normal activities of the farm enterprise by destroying or damaging the capital wealth (tools, livestock, buildings, etc.) on which the farm is dependent for its existence. The magnitude of the disaster may be appreciated by the fact that, in this area, 880 farm units were inundated and thousands of persons were rendered homeless. The crops on these bottom lands, which included cotton, peanuts, corn, soybeans, hay, garden, and pasture, were almost completely destroyed. Since the flood occurred in the crop-growing season, no additional income was realized in 1940 by the replanting of crops.

Loss to Communication Facilities--Communications throughout the entire watershed were seriously interrupted by the 1940 flood. Above Weldon, where the flood plains were comparatively narrow, practically all of the highway crossings were inundated and five bridges on the Roanoke River were destroyed. Below Weldon, the two main highways, which cross the Roanoke River, were seriously damaged, mainly by the breaching of the approaches which are over 4 miles in length. It was estimated that the flooding of these highways forced the suspension of traffic or caused detours for thousands of vehicles over periods of several days to 3 weeks.

Most of the railroad-bridge crossings over the Roanoke River or the approaches thereto were inundated by the flood, and several approach fills were breached. In addition, sections of the railroad tracks located on the flood plain were washed out. Portions of practically all of the railroads in the watershed were affected by the flood.

Utility facilities were disrupted at several places along the Roanoke River. The flood caused material damage to the Virginia Electric and Power Company plant at Roanoke Rapids, which was out of operation for several months.

Relief--Between Weldon and the mouth of the Roanoke River, over 4,000 persons were driven from their homes by the 1940 flood and required relief by public agencies. During the flood, the United States Coast Guard assisted in evacuating families stranded by the rising waters. Temporary refugee camps were established by the North Carolina State and County Departments and were maintained for 30 days after the flood. The Red Cross and the Federal Commodity Credit Corporation rendered aid by furnishing food and clothing. Thousands of persons were inoculated by the State Health Department. After the flood had subsided, the State Health Department, with the assistance of the Work Projects Administration, repaired homes, chlorinated wells on the flood plain, and rebuilt sanitary facilities. Only with the timely assistance of National, State, and local agencies were the widespread impairment of health prevented and the populace partially rehabilitated.

Summary of Flood Damages--The following table summarizes the monetary extent of the damages caused by the August 1940 flood.

Damage Center	Loss
Roanoke Rapids	$961,000
Weldon	112,000
Rural area, Buggs Island to Weldon	168,000
Williamston	98,000
Jamesville	3,000
Plymouth	58,000
Rural area, Weldon to mouth of Roanoke River	1,713,000
Madison	500
Leaksville	100
Rural area, Dan River, headwaters to mouth	318,000
Spray	119,000
Rural area, Smith River, headwaters to mouth	24,000
Approximate total for North Carolina	3,500,000
Total for basin, including Virginia	$5,277,500

A summary of the monetary extent of the damages, caused by the October 1937 flood, follows.

Damage Center	Loss
Rural area, Buggs Island to Weldon	$ 36,000
Rural area, Weldon to mouth of Roanoke River	294,000
Rural area, Dan River, headwaters to mouth	63,000
Spray	30,700
No urban losses in North Carolina except at Spray	
Total for basin	$1,117,700

Estimated losses from the ten floods causing the greatest damage since 1899 in the Roanoke River Valley downstream from Buggs Island are shown below.

Date of flood at Weldon	Crops	Other	Total
May 25, 1901	$399,000	$130,000	$529,000
Oct. 8, 1902	280,000	64,000	344,000
Aug. 28, 1908	419,000	77,000	496,000
Mar. 18, 1912		445,000	445,000
July 23, 1919	387,000	64,000	451,000
Aug. 16, 1928	351,000	54,000	405,000
Oct. 7, 1929	299,000	72,000	371,000
Oct. 24, 1937	270,000	60,000	330,000
July 28, 1938	326,000	42,000	368,000
August 18, 1940	1,027,000	2,088,000	3,115,000

Summary of the Flood Situation in 1943--A considerable amount of industrial, commercial, residential, and other improvements in the Roanoke River Watershed was subject to damage from floods. Practically all of the property subject to damage by floods was located along the Roanoke, Dan, and Smith Rivers. The industrial and commercial establishments and all improvements located on the flood plains of these three streams, exclusive of the value of the land, were estimated to be worth approximately $70,000,000. In the entire watershed, a total of 355,740 acres of land was inundated by the August 1946 flood. The cleared portion of this inundated area amounted to 116,540 acres, of which 82,840 acres were located along the above three rivers.

Considering the existing developments and the damage-frequency relations established by the District Engineer, he estimated the average annual future flood damages at $323,250 for the Roanoke River Valley, $47,250 for the Dan River Valley, and $154,300 for the Smith River Valley, or a total of $524,800. These damages did not include values such as the loss of life or the adverse effect on the living conditions, health, and social security of the thousands of people affected by the floods in these three watersheds.

Methods of Securing Flood Control--In order to determine the most feasible solution for the alleviation of the flood losses at the principal damage centers, the District Engineer considered several plans of improvement. The following methods of securing flood control were investigated: (a) lowering of flood stages by channel improvement, (b) local flood protection by means of flood walls or levees, (c) reservoirs operated entirely for flood control, and (d) multi-purpose reservoir development, combining flood control with water-power production and other functions. To evaluate the merits of each of these methods, annual charges on the estimated cost of the contemplated flood-control works were compared with the average annual benefits resulting from the improvements.

The investigations indicated that the construction of reservoirs for the multiple purposes of flood control, for storage to provide generation of electric power, and for other functions would constitute the most economical method of alleviation of the flood hazard throughout the watershed.

In several instances, channel improvement at local damage centers was considered. This type of improvement was not found to be warranted.

Local Flood Protection--Total damages at Salem, Randolph, and Clarksville in Virginia, and Jamesville in Martin County, North Carolina, have not exceeded $5,000, respectively, in a major flood. Consequently, flood-protection works at

these localities were not warranted. At Altavista, Virginia, the average annual damage did not justify the construction of protective works. At Weldon, the average annual damages of $4,100 did not justify the construction of drainage facilities and 7,000 feet of levee required to protect this city. Local protection plans at Williamston and Plymouth were complicated by the navigation improvements existing at these cities, and the total average annual flood damages thereat were not sufficient to warrant local protection. The annual charges and annual benefits of local protection at Roanoke were found to be $8,900 and $3,600, respectively. The annual charges and annual benefits of construction of levees and a concrete wall, considered for the protection of industrial plants at Roanoke Rapids against all floods to the August 1940 stage, were found to be $46,500 and $31,000, respectively. Flood-control improvements for the protection of urban areas in the Dan River Valley and the Smith River Valley could not be economically justified. Study of local flood-control measures for agricultural lands located on the flood plains in the upper Roanoke River Valley and in the Dan and Smith River Valleys resulted in the same conclusion. It was found that an estimated total of $4,118,000 would be required to construct local flood-control works, providing protection against river stages equal to those of the August 1940 flood at Roanoke, Roanoke Rapids, and for three large agricultural areas below Weldon, known locally as Occoneechee Neck, Caledonia, and Norfleet. The annual charges on this investment would have been $174,700, compared to the resulting average annual flood-control benefits of $102,000, or an unfavorable economic ratio of 1 to 0.59.

Flood Protection by Reservoirs— Reservoirs considered for operation entirely for flood control included dams at the Buggs Island, Randolph, and Smith Mountain sites on the Roanoke River, the Schoolfield site on the Dan River, and the Philpott site on the Smith River. These sites were the most outstanding sites available where adequate drainage area would be controlled and sufficient storage capacity could be made available at reasonable cost. The economics of reservoirs for flood control only at these sites were found to be as shown in the following table.

Storage capacity available for flood control	Estimated investment	Annual charges	Annual benefits	Benefit-Cost ratio
		Buggs Island		
416,000 acre-feet	$11,000,000	$496,000	$194,000	0.39
832,000 acre-feet	15,400,000	694,000	228,000	0.33
		Randolph		
159,000 acre feet	$6,600,000	$298,400	$217,000	0.73
318,000 acre-feet	8,100,000	362,300	233,000	0.64
		Smith Mountain		
326,000 acre-feet	$6,480,000	$296,500	$143,000	0.48
		Schoolfield		
102,000 acre-feet	$5,400,000	$243,700	$73,000	0.30
204,000 acre-feet	7,100,000	319,800	144,000	0.45

Philpott

67,700 acre-feet	$2,873,000	$132,200	$150,300	1.14
90,300 acre-feet	2,948,000	135,600	150,300	1.11

As indicated in the above table, only the reservoir development entirely for flood control at the Philpott site on the Smith River was found to be warranted, and an earth fill type at the Philpott site, with a spillway crest elevation of 941, having a storage capacity below the spillway crest equivalent to 8 inches of run-off over the tributary drainage area, was considered the most favorable for development, provided that storage for the production of hydroelectric energy would not be adopted in the initial plans for construction. It was also found that the economic ratio could be increased to 1.18 if the reservoir with the dam at the Philpott site were constructed for the dual purposes of flood control and low-water regulation. The total annual benefits from low-water regulation were estimated at $10,000.

Comprehensive Plan of Reservoir Development--The report contained in House Document No. 65, Seventy-fourth Congress, first session, outlined above, indicated that, at the time of the report (1934), 17 outstanding reservoir sites on the Roanoke and Dan Rivers were worthy of consideration for the production of electric energy. These sites included Smith Mountain, Randolph, Buggs Island, Gaston, and Roanoke Rapids, and did not include Philpott and Schoolfield. It was determined in 1934 that this combination of reservoirs could have been developed for the maximum utilization of the potential water power of the basin.

Investigations for water power and flood control of the reservoirs in the 1934 plan and others were made to determine their economic feasibility in 1943. It was determined that two alternative systems of reservoirs were possible and that either one would be justified for the comprehensive development of the potential water power in the basin. These plans are referred to in the report contained in Document 650 as the "preferred plan" and the "alternative plan". The preferred plan covered 11 reservoirs at the Buggs Island, Gaston, Roanoke Rapids, Smith Mountain, Leesville, Taber, Melrose, Randolph, Philpott, Stuart, and Schoolfield Sites. The alternative plan provided for 13 reservoirs at the Buggs Island, Gaston, Roanoke Rapids, Randolph, Clarksville, Smith Mountain, Leesville, Taber, Seneca, Melrose, Schoolfield, Philpott, and Stuart sites. In the preferred plan, the Buggs Island Project, constructed to elevation 317 instead of elevation 277, would replace the smaller dam at Buggs Island and the Clarksville Dam in the alternative plan, and the Seneca and Melrose projects would be combined by the construction of Melrose Dam to elevation 486 in the preferred plan instead of elevation 463 in the alternative plan.

A priority of construction was established for the orderly development of each of these plans. In each case, the most economical reservoir, operated by itself for production of water power, was assumed to be built first. Thereafter, reservoirs were to be added to make the system as a whole the most economical at any given stage of development. The economic justification of each system was determined mainly by the value of its potential power output, compared with the cost of electrical energy generated at a possible new modern steam plant operating on a 50-percent capacity-factor basis.

The economics of the two plans are shown in the following table.

	Preferred plan	Alternative Plan
Construction investment, exclusive of transformers, switching stations, and transformer lines	$111,730,000	$113,170,000
Estimated annual charges	5,223,300	$ 5,293,100
Estimated annual benefits	7,692,400	7,676,100
Benefit-cost ratio	1.47	1.45

Recommended Plan--The District Engineer established a recommended plan for the orderly development of the Roanoke River Basin, consisting of 11 reservoirs which would cost approximately $124,000,000, including transformers, plant-switching stations, transmission lines, and terminal substations. The ultimate development would have an installed electrical-generating capacity of about 360,000 kilowatts which could generate about 1,700 million kilowatt hours of energy in the average year, of which about 1,300 million kilowatt hours could be generated in a year comparable to the driest of record. The annual benefits from the ultimate plan would exceed the annual charges by 47 percent.

An orderly plan of development was established by determining the priority of construction for the several projects in the comprehensive system. The first two projects to be constructed would be the Buggs Island project on the Roanoke River and the Philpott project on the Smith River. These two multi-purpose projects would cost about $30,900,000 and $5,240,000,respectively, and would generate a total of 455 million kilowatt-hours in the average year, of which 300 million kilowatt-hours would be prime energy from an installed generating capacity of 94,500 kilowatts. The average annual benefits from these two projects would exceed the average annual charges by 35 percent. The storage reservoirs contemplated in the recommended plan would provide sufficient flow to extend navigation facilities from the present head of navigation at Palmyra to Weldon by the construction of one lock and dam on the Roanoke River at Mile 114 about five miles below Halifax, should such facilities be found to be warranted in the future. The unevaluated benefits would be as follows;

(a) Reduction of the probability of loss of life in the future during floods in the Roanoke River Basin.
(b) Reduction of damages to normal future property development.
(c) Reduction of soil erosion downstream from the dams.
(d) Conservation values as wildlife refuge areas.
(e) Recreational values.
(f) Possible values of some of the reservoirs for future domestic water-supply and for stream-pollution abatement.
(g) Value of the proposed reservoirs as a factor which should aid in the further industrial development of the southern part of Virginia and the northern part of North Carolina.
(h) Value of the regulation of stream flow, resulting from the storage reservoirs, in the future extension of the navigation project to Weldon.
(i) Value of the power developments in time of war or during other power emergencies.

Action by the Chief of Engineers--With his letter of May 22, 1944 to the Chairman, Committee on Flood Control, U. S. House of Representatives, the Chief of Engineers, U. S. Army, enclosed the report of the Board of Engineers for Rivers and Harbors in response to the request of the Committee on Flood Control by resolution dated August 28, 1940, and the request of the Committee on Rivers and Harbors,

dated January 26, 1942, to review the reports on the Roanoke River as contained in House Document No. 65, 74th Congress, 1st Session. The Chief of Engineers stated that the Board, concurring in general with the district and division engineers, found that a comprehensive plan of improvement, consisting of 11 developments for hydroelectric power, flood control, navigation, and other uses, was economically justified and provided the best plan for the development of the water resources of the Roanoke River Basin. The Chief of Engineers further stated that the Board recommended improvement of the Roanoke River and tributaries for flood control, navigation, and the generation, transmission, and sale of hydroelectric power, and for other beneficial uses by the construction of dams and hydroelectric power plants at Buggs Island, Gaston, Roanoke Rapids, Smith Mountain, Leesville, Taber, Melrose, Randolph, Philpott, Stuart, and Schoolfield, generally in accordance with the plans of the district engineer and with modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable.

The Chief of Engineers recommended that the general plan of development outlined in the report of the district engineer be adopted as the basis for improvement, step by step, of Roanoke River and tributaries for flood control, navigation, and other purposes, and that the Buggs Island and Philpott projects be authorized for construction as the initial step, generally in accordance with the plans of the District Engineer and with modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, at an estimated cost of $36,140,000 for construction and $164,100 annually for operation and maintenance.

Further Congressional Action and Results Thereof - The Flood Control Act of 1944 approved the general plan for the comprehensive development of the Roanoke River Basin for flood control and other purposes, and authorized the construction of the John H. Kerr and Philpott Reservoirs. The approved plan provides for the construction of the eleven reservoir projects indicated above.

The Congress of the United States appropriated funds in March 1945 to start the detailed planning for the John H. Kerr Project. Between March 1945 and February 1946, the definite project plan was developed with the assistance of such Federal agencies as the U. S. Fish and Wildlife Service, U. S. Public Health Service, and National Park Service. Each of these agencies coordinated their activities with the appropriate State agencies in Virginia and North Carolina in preparing their sections of the Definite Project Report. A public hearing on the entire matter was held at South Hill, Virginia, on December 5, 1945. Following the preparation of the Definite Project Report, plans and specifications were prepared to accomplish construction of the project which was initiated in February 1946.

The Congress appropriated funds in December 1945 to start the detailed planning for the Philpott Project. Between December 1945 and January 1948, the Definite Project Report for this project was developed, and plans and specifications were prepared to accomplish construction of this project which was initiated in January 1948.

The John H. Kerr and Philpott projects have been completed and are in operation. The Roanoke Rapids Project has been constructed and is in operation by the Virginia Electric and Power Company. An application to construct the Gaston Project has been submitted by this Company to the Federal Power Commission.

John H. Kerr Reservoir--The John H. Kerr Dam is on the Roanoke River in Virginia, about 49 miles above Weldon and 20 miles above the Virginia-North Carolina State line. The reservoir lies partially in Virginia and partially in North Carolina. The drainage area above the John H. Kerr Dam is 7,800 square miles.

The John H. Kerr Dam and Reservoir is a 117,300-acre multi-purpose project of the Corps of Engineers, U. S. Army, providing flood control for the lower 178 miles of the Roanoke River, and a hydro-electric powerhouse for distribution of electric power to local power companies. The dam creates a lake of 48,900 acres at normal summer elevation of 300 feet above sea level. The maximum flood storage capacity at 320 feet elevation is 1,278,000 acre-feet. There are 800 miles of shoreline.

The dam consists of a concrete gravity structure flanked on both ends by earth embankments. The overall length is 22,285 feet, of which the length of the earth fill saddle and wing dikes totals 19,500 feet and the length of the concrete gravity structure is 2,785 feet. The maximum height of the concrete portion of the dam is 144 feet. The spillway section is located across the original stream bed and is surmounted by 22 tainter gates, 42 feet wide by 32 feet high. Six conduits, 5 feet 8 inches wide by 10 feet high, control discharges of water through the dam. Seven penstocks guide the flow of water through 7 generating units with a total capacity of 204,000 kilowatts.

The project is the most important unit in the comprehensive plan for flood control and other purposes in the Roanoke River Basin. The project was authorized primarily for the control of floods and generation of hydroelectric power. It provides however, important incidental benefits such as recreation, water supply, fish and wildlife preservation, and low flow regulation.

The project affords flood protection to cities and towns as well as to the productive farm lands in the lower Roanoke River Valley, mostly in North Carolina. The project provided some capacity for flood control after February 1953, There have been no major floods since the flood-control capacity has been available. Some damages have been prevented downstream, however, in minor floods, including those associated with Hurricane Hazel in 1954 when damages estimated at $250,000 were prevented.

Generation of power began in November 1952, and, by December 1953, all units were available for operation. The power produced has been marketed by the Southeastern Power Administration, the Federal agency responsible for marketing power available from Federal projects in the southeastern United States. As of January 1, 1955, all power produced has been fed into the system of the Virginia Electric and Power Company for sale by that company and for transmission to preference customers. Preference customers include twelve cooperatives in Virginia and five in North Carolina. Negotiation of a contract for the sale of a portion of Kerr power to the Carolina Power and Light Company has been accomplished.

The project was 97 percent completed as of June 30, 1954. The estimated cost of the completed project is $87,150,000. The annual charges are $4,777,800 including interest on the investment, amortization of the project in 50 years, taxes on the alternative, privately-financed power source which will be foregone, and the cost of operation and maintenance. Average annual benefits from the project excluding increased power benefits due to the operation of a small upstream Federal project (Phillpott Reservoir), are estimated as follows:

a.	From the control of floods	$795,000
b.	From the production of power	4,655,800
	Total average annual benefits	$5,450,800

Philpott Reservoir--The Philpott Dam and Reservoir is an integral unit in the comprehensive plan for the development of the water resources of the Roanoke River Basin. The dam is on Smith River in Virginia, seven miles upstream from Bassett and about 35 miles above the Virginia-North Carolina State Line. The drainage area above the Philpott Dam is 212 square miles.

The dam consists of a concrete gravity structure 920 feet long and 219 feet high at the highest point. The spillway section is ungated and is located in the old stream bed. Three conduits, 5 feet 8 inches wide and 10 feet high, control discharges through the dam. Three penstocks guide the flow of water through three generating units with a total capacity of 14,000 kilowatts.

The project is being operated primarily for control of floods and generation of hydroelectric power. It has provided flood protection to the cities and towns in the Smith River Valley below the dam, including Spray, North Carolina, about 2.5 miles north of Leaksville in Rockingham County. The project has provided some capacity for the control of floods since March 1951, and full capacity has been available since January 1953; no major floods, however, have occurred since that time.

Generation of power began in September 1953. The power produced has been fed into the system of the Appalachian Electric Power Company in accordance with a contract consummated by this company with the Southeastern Power Administration, the Federal agency that markets power available at Federal projects in this area.

The project was 99 per cent completed on June 30, 1954. The estimated cost of the completed project is $13,340,000. The annual charges are $772,700, including interest on the investment, amortization of the investment in 50 years, taxes on the alternative, privately-financed power source which will be foregone, and the cost of operation and maintenance. Average annual benefits from the project, including increased power benefits resulting at the John H. Kerr Project from the operation of the Philpott Project are estimated as follows:

a.	From the control of floods	$315,500
b.	From the production of power	481,600
	Total average annual benefits	$797,100

Sale of John H. Kerr and Philpott Electric Power-- The electricity generated at the Kerr and Philpott projects is sold by the Southeastern Power Administration, United States Department of the Interior, as provided for in the Flood Control Act of 1944. Section 5 of that act contains the following provisions:

"Electric power and energy generated at reservoir projects, under the control of the War Department and in the opinion of the Secretary of War not required in the operation of such projects, shall be delivered to the Secretary of the Interior, who shall transmit and dispose of such power and energy in such manner as to encourage the most widespread use thereof at the lowest possible rates to consumers consistent with sound business principles, the rate schedules to become effective upon confirmation and approval by the Federal Power Commission. Rate schedules shall be drawn having regard to the recovery (upon the basis of the application of such rate schedules to the capacity of the electric facilities of the projects) of the cost of producing and transmitting such electric energy, including

the amortization of the capital investment allocated to power over a reasonable period of years. Preference in the sale of such power and energy shall be given to public bodies and cooperatives. The Secretary of the Interior is authorized, from funds to be appropriated by the Congress, to construct or acquire, by purchase or other agreement, only such transmission lines and related facilities as may be necessary in order to make the power and energy generated at said projects available in wholesale quantities for sale on fair and reasonable terms and conditions to facilities owned by the Federal Government, public bodies, cooperatives, and privately owned companies. All moneys received from such sales shall be deposited in the Treasury of the United States as miscellaneous receipts."

Roanoke Rapids Project - The construction of this project by the Virginia Electric and Power Company near the Town of Roanoke Rapids, North Carolina, was started in 1952. About the middle of July 1955, water began to rise in the lake behind the dam and the first of four water-wheel generators was put on the line. The other three generators will be put in operation by the end of 1955, producing electricity for home, farm, store, and industry. As of June 24, 1955, over 115,000 people had visited the dam site, coming from some 38 states and 20 foreign countires.

The dam will create a lake ten miles long with a shoreline measuring 47 miles. The dam's tail-race alone produced enough rock to ballast the Seaboard Air Line Railroad tracks from Richmond to Raleigh. Many trainloads of cement, gravel, and sand went into making a dam over half a mile long and as high as an 8-story building.

When completed in 1956, the dam and power station will cost an estimated $34,000,000 and will be capable of generating 100,000 kilowatts of electricity. This capacity is more than is required to serve all VEPCO customers throughout the company's service area in Northeastern North Carolina, or a city of approximately 200,000 population.

The dam is 3,050 feet in length and will form a reservoir, about nine miles long and containing 4,900 acres. The services of some 1,200 men were required in building the dam, and work went on 24 hours a day. A total of about 7,500,000 man-hours was used. Going into the dam construction were 285,000 cubic yards of concrete, the same amount needed to build a sidewalk six feet wide and 189 miles long. The concrete mix used 800,000 bags of cement, 300,000 tons of crushed stone, and 120,000 tons of sand. The tail race will extend downstream for 8,000 feet, is 85 feet wide, and has an average depth of 45 feet. It was drilled and blasted from solid rock, as was the site for the power station.

When it goes into operation, the Roanoke Rapids Project will be VEPCO's ninth major generating plant and will be tied into the company's high-voltage transmission system. The company has applied to the Federal Power Commission for a license to build another dam and power station, similar to the Roanoke Rapids Project, about ten miles upstream at the Gaston site. It is understood that, when both the Roanoke Rapids and Gaston Projects are completed, the Roanoke Rapids dam would back water up to the toe of the Gaston Dam, which would back water up to the toe of the John H. Kerr Dam.

Data pertaining to the Roanoke Rapids project follows.

Purposes of Project
Hydroelectric Power

Incidental Benefits including Recreation and Fish and Wildlife Preservation

River Flows at Dam Site	
Natural Flow	
Average Annual Flow	8,500 c. f. s.
Maximum Flow of Record, August 18, 1940	261,000 c. f. s.
Minimum Flow of Record, Sept. 31, 1932	458 c. f. s.
Discharge Capacity of Turbines	17,600 c. f. s.
Reservoir	
Counties Affected--Halifax and Northampton	
Characteristics of Reservoir--Elev. 132 at Dam	
Length of Reservoir	9 miles
Length of Shoreline	47 miles
Maximum Width	1¼ miles
Storage	85,000 Acre-Feet
Reservoir Surface	4,900 Acres
Dam	
Length	3,050 Feet
Maximum Height	72 Feet
Crest Gates	
Type	Radial
Number	24
Size (Length by height)	38 x 23¼ Feet
Intake Openings	
Number (3 for each turbine)	12
Size (width by height)	10 x 32½ Feet
Tailrace	
Length	8,000 Feet
Width	80 Feet
Depth (average)	45 Feet
Elevations (Feet above mean sea level)	142
Top of Dam	70
Base of Dam	7
Base of Power House	15
Top of Radial Gates	132.75
Crest of Concrete Spillway	109.5
Normal Full Power Pool	132

Power House Generating Units
4 Adjustable Blade Propeller Type Turbines:
35,000 Horse Power
74½ Foot Head
128.6 Revolutions per minute
4 Generators @ 25,000 Kilowatts Each:
100,000 Kilowatts

Construction Quantities (Approximate)	
Concrete	285,000 cu. yds.

Earth Excavation	84,000 cu. yds.
Rock Excavation	1,442,000 cu. yds.
Drilling for Foundation	30,000 lin. ft.

Gaston Project—The following information regarding the Gaston hydroelectric development, as contained in the application of Virginia Electric Power Company before the Federal Power Commission, is not final, as the Federal Power Commission, at the time of preparation of this publication, had not approved or disapproved the application, and VEPCO had not received a permit for the construction of the Gaston Project.

Purpose	Hydroelectric Power
Location-River	Roanoke
Miles above mouth	About 147.5
Counties Affected	
In State of North Carolina	Halifax, Warren, and Northampton
In State of Virginia	Brunswick and Mecklenburg
Drainage Area-Square miles	8,320

River Flows at Dam Site:

Natural Flow:	
Average Annual Flow	8,500 c.f.s.
Maximum Flow of Record (Aug. 18, 1940)	267,000 c.f.s.
Minimum Flow of Record (Sept. 21, 1932)	458 c.f.s.

Reservoir Characteristics at Elevation 200

Length	35 miles
Storage	267,000 Acre-Feet
Surface	18,500 Acres

Dam

Length (Concrete)	2,580 feet
Maximum Height	80 feet
Crest Gates	
Type	Radial
Number	24
Size (Length by width)	38 x 25½ feet

Elevations, Feet above M. S. L.

Top of Dam	210
Base of Dam	130
Top of Spillway Gates	203
Crest of Concrete Spillway	177.5
Normal Full Power Pool	200
Normal Tailwater Corresponding to Normal Full Pool	132.5

Power House Generating Units

3 Adjustable-blade propeller-type turbines would be provided initially, each rated about 40,000 H. P. at 67-ft. net head. Provisions would be made for the addition of a fourth unit of similar rating to be installed at some future date.

3 Generators, rated at 28,800 Kw each or a total of 86,400 Kw, would be installed initially. Ultimately, a fourth unit of similar rating would be added.

Further Information regarding the Roanoke Rapids Project - - The project was completed during the first half of 1956 and was in full operation at the time of printing of this publication.